1331

"REFERENCE COPY"

Water Plant Optimization Study

OSHAWA WATER TREATMENT PLANT

December 1990

Environment
Environnement
Ontario

Ontario
Environment
Environnement

ISBN 0-7729-3307-3

Water Plant Optimization Study

Oshawa
Water Treatment Plant

Project No. 7-2020

December 1990

study conducted by:
W.J. Hargrave and A.L. Loucks
of

Gore & Storrie Limited

Under the direction of the
Oshawa Project Committee:

Gary Martin — MOE Water Resources Branch
Art Leitch — Regional Municipality of Durham
Lloyd Murray — Regional Municipality of Durham
Dave Johnson — Regional Municipality of Durham
Frank Reinholz — MOE Central Region
Bill Gregson – MOE Project Engineering Branch
Janusz Budziakowski – MOE Environmental Approvals Branch
Gerry Sigal – R.V. Anderson Associates Limited

Address all correspondence to:
Ministry of the Environment
Water Resources Branch
1 St. Clair Ave. W., 4th Floor
Toronto, Ontario
M4V 1K6

©1990 Her Majesty the Queen in right of Ontario
as represented by the Minister of the Environment

Please note that some of the recommendations contained in this report may have already been completed at time of publication. For more information, please contact the local municipality, or the Water Resources Branch of the Ministry of the Environment.

Cette publication technique n'est disponible qu'en anglais.

PRINTED ON
RECYCLED PAPER
IMPRIME SUR
DU PAPIER RECYCLE

PIBS 1331

WATER PLANT OPTIMIZATION STUDY
OSHAWA WATER TREATMENT PLANT

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The purpose of the Water Plant Optimization Study (WPOS) is to document and review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on the removal of particulate materials and the disinfection processes.

In striving for excellence in water treatment, it is important to examine all possible approaches, but first, optimum use should be made of the processes already in place.

This optimization study is a beginning and not an end to itself; it is the start of an ongoing documentation of the operation of the plant. It is recommended that this document be updated on an annual basis.

In an effort to optimize particulate removal and disinfection at the Oshawa Plant, the following are suggested:

PHYSICAL IMPROVEMENTS

- Install separate alum feed systems for each raw water header.
- Convert top entry flocculation tanks in the Old Plant to bottom entry.
- Install individual filter effluent turbidimeters or turbidity monitoring stations on the effluents of the Plant 1 filters.
- Install two weigh scales to allow individual weighing of pre- and post-chlorine feeds.
- Modify the roof drains to not empty into the filters.

STUDIES

- Conduct laboratory tests to determine the relative merits of blending and flash mixing.
- Conduct a study to determine if the current practice of adding alum and fluoride at the same location is responsible for fluoride consumption.
- Continue to conduct tests to evaluate the merits of a streaming current monitor.
- Continue to conduct laboratory tests to evaluate the effectiveness of various coagulants and coagulant aids.

STUDIES (cont'd)

- Investigate the backwash procedure to ensure that the low and high wash rates provide an adequate backwash.

OTHER RECOMMENDATIONS

- Conduct sieve and grain size characterization tests on each filter once every five years. Measure the depth of the media each year.
- Record a turbidity profile consisting of raw, settled, and filtered turbidities for each of the plants.
- Prepare a process and piping diagram (PAPD) for the Oshawa plant.
- The Ministry of the Environment should develop a surrogate measurement for chlorinated by-products for use in water plants in Ontario.

TABLE OF CONTENTS

Summary of Findings and Recommendations
Table of Contents
Introduction and Terms of Reference

Page No.

SECTION A RAW WATER SOURCE

A.1 General Quality 1

SECTION B FLOW MEASUREMENT

B.1 Raw 3
B.2 Treated 3
B.3 Backwash 4
B.4 Filters 4
B.5 Validity 5

SECTION C PROCESS COMPONENTS

C.1 General 6
C.2 Design Data 6
  (a) Plant Capacity 6
  (b) Intake 7
  (c) Intake Well 7
  (d) Screening 7
  (e) Low Lift Pumping 8
  (f) Flash Mixing 8
  (g) Flocculation 8
  (h) Settling 11
  (i) Filters 12
  (j) Clearwells 16
  (k) High Lift Pumping 17
  (l) Backwash Treatment 17
  (m) Sludge Disposal 17
C.3 Chemical Systems 18
  (a) Disinfectant 18
  (b) Coagulant 19
  (c) Fluoride 19
C.4 Drawings 20
  (a) Site Plan 20
  (b) Process and Piping Diagram 20
  (c) Block Schematic 20
  (d) Photographs 20

TABLE OF CONTENTS (cont'd)

Page

SECTION D PLANT OPERATION

D.1 Plant Operation 36
- (a) General 36
- (b) Personnel 36
- (c) Flow Control 37
- (d) Filter Backwashing 38
- (e) Chemical Dosage Control 38
- (f) Quality Control Testing 41

D.2 Operation and Process Concerns 44
- (a) Flocculaton Mixing 44
- (b) Filters 44
- (c) Filter Backwashing 44
- (d) Plant Effluent Turbidity 45
- (e) Aluminum Residual 45

SECTION E PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 Turbidity Removal 46
- (a) General 46
- (b) Plant Performance 47

E.2 Treatability Testing 49
- (a) Jar Testing 49
- (b) Streaming Current Monitor 52

E.3 Optimum Removal Strategies 53
- (a) Flash Mixing and Coagulant Addition 53
- (b) Flocculation and Sedimentation 53
- (c) Filter Turbidity Monitoring 54
- (d) Turbidity Profile 54

SECTION F PLANT PERFORMANCE (DISINFECTION)

F.1 Disinfection 55

F.2 Disinfection Efficiency 55

F.3 Chlorinated By-Products 57

TABLE OF CONTENTS (cont'd)

Page

SECTION G SHORT AND LONG-TERM MODIFICATIONS

G.1 Description 60
G.2 Coagulant Application Point 60
G.3 Fluoride Application 60
G.4 Chemical Mixing 61
G.5 Streaming Current Monitor (SCM) 61
G.6 Coagulant and Coagulant Aids 62
G.7 Coagulant Dosage 62
G.8 Flow Pattern in Flocculation Tanks 63
G.9 Filter Cleaning 63
G.10 Filter Media Characteristics 64
G.11 Filter Effluent Turbidimeters 64
G.12 Turbidity Profile 64
G.13 Chlorine Dosage and Verification 65
G.14 Roof Drains 65
G.15 Record of Information 65
G.16 Chlorinated By-Products 66

APPENDIX A TABLES

APPENDIX B FILTER BACKWASHING GUIDELINES AND PROCEDURE

APPENDIX C GRAPHICAL TURBIDITY DATA

APPENDIX D JAR TESTING

APPENDIX E DAILY RECORD

APPENDIX F BACTERIOLOGICAL TEST PROCEDURES

APPENDIX G COMPUTER PRINTOUTS - OPERATIONAL SUMMARIES

TERMS OF REFERENCE

INTRODUCTION AND TERMS OF REFERENCE

The Ontario Ministry of the Environment has instituted a Drinking Water Surveillance Program, consisting of a continuously updated data base of water quality information on Ontario water treatment plants. In connection with the surveillance program, a specific plant investigation and process evaluation study is desired for each plant entering the program. The study is to document and review the present operating conditions, and determine an optimum treatment strategy for particulate removal and disinfection at the plant. The terms of reference for this Water Plant Optimization Study has been prepared by the Ministry, and is included at the back of the report, following the appendices. This optimization study has been conducted in accordance with the terms of reference and information package.

The Oshawa plant, along with the Ajax and Whitby water treatment plants, provide water to an overall system which serves an area that extends into Pickering, Ajax, Whitby, Oshawa, and the Courtice area in Newcastle. The Oshawa plant is usually operated as the base plant.

This optimization study provides a detailed examination of three years of daily and monthly Oshawa plant operating data, a description of the facilities in place at the plant and their operation, and recommendations which could improve the particulate removal and disinfection performance of the plant.

The Oshawa Water Supply Plant draws water from Lake Ontario, which experiences its worst water quality during the spring (March-April) and fall (November-December) months when the raw water turbidity increases. Overall, the operation of the Oshawa plant is very good, and the plant consistently produces a water with a turbidity of much less than 1.0 FTU.

SECTION A

RAW WATER SOURCE

SECTION A
RAW WATER SOURCE

A.1 General Quality

The Oshawa Plant draws water from Lake Ontario. Oshawa is located on the north shore of Lake Ontario, approximately 50 km east of Toronto. The raw water is generally good, with occasional high turbidity and coliform counts.

The Oshawa Water Pollution Control Plant is located to the east of the water plant. The pollution control plant has a shoreline discharge and the Oshawa water plant staff does not believe this plant influences the intake raw water quality. There is very little industrial development near the plant, and the possibility for industrial contaminants to be introduced into the raw water is quite low. No industrial contaminants have been detected in the raw water to date.

The Oshawa Water Supply Plant security measures consist of keeping all doors locked and a padlock on the gate leading onto the property after working hours. The water plant property is entirely fenced. Should a spill or other security event occur, the plant would call the Ontario Ministry of the Environment Spills Action Centre for further direction on plant operations.

In the years 1985 to 1987, the raw water quality parameters varied as follows:

Turbidity (FTU)	0.24 - 75	(1)
Colour (HCU)	2.5 - 7.5	(2)
Temperature (°C)	0 - 23	(1)
pH	6.8 - 8.4	(3)
Hardness (mg/L as $CaCO_3$)	126 - 137	(2)
Alkalinity (mg/L as $CaCO_3$)	81.2 - 105.9	(2)
Aluminum (mg/L)	<0.004 - 0.073	(2)
Iron (mg/L)	<0.05 - 0.29	(4)
Manganese (mg/L)	0.001 - 0.003	(5)
Fecal Coliform (per 100 mL)	<2 - 3000	(2)
Total Coliform (per 100 mL)	0 - 3000	(2)

A.1 General Quality (cont'd)

Notes:

(1) Data obtained from Daily Log Sheets.

(2) Data obtained from DWSP and MOE Sampling Sheets.

(3) Data obtained from Daily Comparison Cl^- and F Analyzers and Lab Test Sheets.

(4) Result of 6 tests obtained from DWSP and MOE Sampling Sheets.

(5) Result of 4 tests obtained from DWSP.

SECTION B

FLOW MEASUREMENT

SECTION B
FLOW MEASUREMENT

B.1 Raw

The raw water flow at the Oshawa plant is measured by a 600 mm diameter venturi tube which has a 1496 mm water column differential at 136 ML/d (58.91 inches at 30 MGD). A Bristol transmitter send a 4-20 mA signal to the computer. The computer continuously totalizes the raw water flow, and the flow rate can be obtained at any time.

At the present time, operators also record the raw water integrator reading at midnight on the daily log. The raw water flow is totalled for the day.

B.2 Treated

There are two treated water discharge mains leaving the Oshawa plant; one main is fed by the diesel pumps (TWI), the other is fed by the electric pumps (TW2). Each main has its own meter and Bristol transmitter, which sends a 4-20 mA signal to the computer.

TW1 - 762 mm diameter BIF venturi tube, 1541 mm water column differential at 72 ML/d (60.68 inches at 15.8 MGD)

TW2 - 762 mm diameter BIF venturi tube, 1541 mm water column differential at 113.5 ML/d (60.68 inches at 25 MGD)

The treated water flow is totalized and recorded continuously on a chart in the administration area. The totalized flow is also continuously recorded in the computer. At midnight, the daily production information is stored in the computer.

B.3 Backwash

There is one 72.6 ML/d (50.4 m^3/min) backwash pump which discharges into a 610 mm diameter washwater header. The flow in this header is measured by a venturi tube, which has a 3048 mm water column differential at 62.4 ML/d (120 inches at 13.7 MGD).

A Bristol transmitter sends a 4-20 mA signal to the computer. The frequency, volume, and duration of each backwash is recorded in the computer, as is the total backwash water volume for the day.

B.4 Filters

The Old Plant has eight original filters, numbered 1 to 8. The filter effluent valve position is manually controlled, and the filters do not have any flow indicators on the effluents.

In 1953, the New Plant was built with Filters 1-2. Filters 3 and 4 were added in 1960, and Filters 5 and 6 were added in 1965. All of the New Plant filter effluents have flow meters and transmitters, as tabulated below.

Filter No.	Meter	Size mm	Capacity (ML/d)	Transmitter	Diff. Pressure (mm)
1	venturi tube	330	18	Bristol	1524
2	venturi tube	305	18	Bristol	1524
3	universal venturi tube	305	18	Bristol	1920.5
4	universal venturi tube	305	18	Bristol	1920.5
5	venturi tube	305	18	Bristol	1524
6	venturi tube	305	18	Bristol	1524

The maximum filter rates are set individually at each filter. The filter rates of the filters in the Old Plant are set depending on the low lift pumpage. The New Plant filter flow rates can be cut back by a clearwell level override.

B.5 Validity

There are no reported problems with the accuracy of flow metering (raw and treated) at the plant. The only area of uncertainty is the flow from the Old Plant filters, since there are no filter effluent flow indicators. All other flow meters are on a preventative maintenance program, and the transmitters are checked and calibrated by the Region's instrumentation staff, if required, every three months.

The flow data in Table 1.0, Appendix A, shows a consistent and systematic set of information, with no obvious discrepancies present during the 1985 - 1987 period.

The per capita flow data could not be determined since the Oshawa plant supplies water to different areas (ie. Oshawa, Whitby, Ajax, Pickering), depending upon the operation of the Whitby and Ajax plants.

SECTION C

PROCESS COMPONENTS

SECTION C
PROCESS COMPONENTS

C.1 General

This section includes detailed information on design data and chemical systems, a site plan, a block flow diagram, and a series of photographs to illustrate the major plant components and chemical feed systems. Figure 1, opposite the following page, illustrates the process configuration at the Oshawa plant.

C.2 Design Data

(a) Plant Capacity

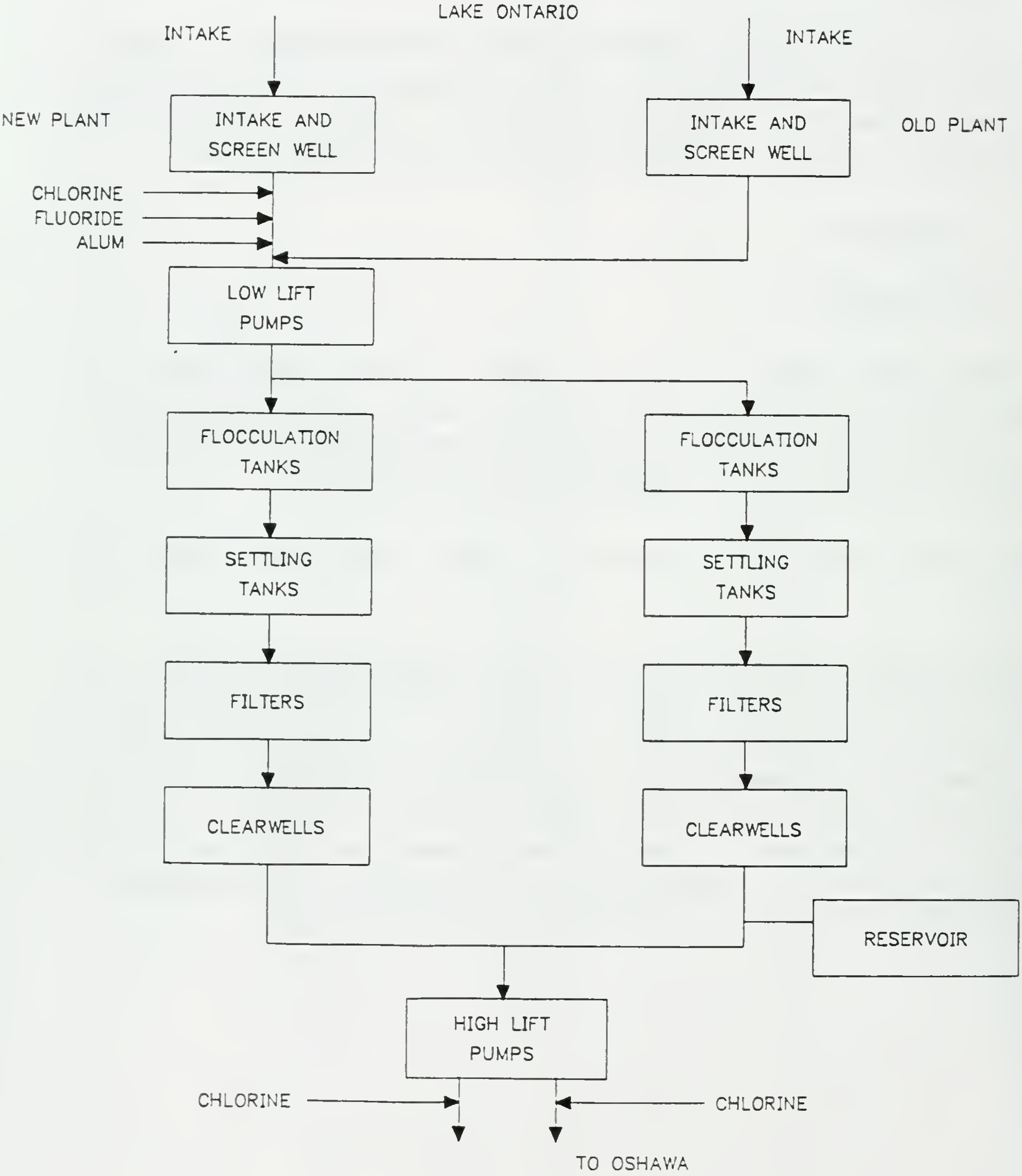
The original pumping station was built in 1904. In 1931, flocculation and sedimentation tanks, Filters 1-8, and appropriate pumping, were added to the Old Plant. The New Plant was added in three stages in 1953, 1960, and 1965. Each stage added flocculation and sedimentation tanks, and two filters.

Numerous piping, pumping and instrumentation changes have occurred over the years.

The maximum hydraulic capacity of the facilities is approximately 114 ML/d, with a present average daily flow of about 85 ML/d. All of the operating data presented herein are based on flows of 85 and 114 ML/d. The Old and New Plants have maximum hydraulic capacities of 27 and 87 ML/d, respectively. For the purposes of this report, it has been asumed that the flow splits in this proportion to the two plants. It has also been assumed that the raw water flow to each of the plants splits evenly between the various sets of mixing chambers. The capacities of all filters are tabulated on the following page:

FIGURE 1

OSHAWA WATER TREATMENT PLANT
PROCESS AND PIPING SCHEMATIC



(a) Plant Capacity (cont'd)

	FILTER NO.	HYDRAULIC CAPACITY (ML/d)
OLD PLANT	1 - 8	3.4 ea.
NEW PLANT	1 - 2	13.6 ea.
	3 - 4	12.7 ea.
	5 - 6	17.2 ea.
	TOTAL	114.2

(b) Intake

Old Intake - 831 long, 762 mm diameter steel intake pipe
- concrete filled timber crib with bell mouth opening
- water depth to top of slab is 7.9 m (lake level = 75.2 m)

New Intake - 924 m long, 914 mm diameter steel intake pipe
- concrete filled timber crib, 3.35 m square with 1.83 m square flared opening
- water depth to opening is 10.2 m (lake level = 75.2 m)

The combined intake capacity, depending on the lake level, ranges from 110 to 135 ML/d. The lake level varies between 74.4 and 75.4 m.

(c) Intake Well

The two intake pipes terminate in two intake wells. The Old intake well is 3.05 m in diameter by 5.2 m deep. The New intake well is 14.2 m x 2.4 m x 4.7 m deep.

(d) Screening

The Old intake well contains one stationary screen, 4.6 m x 2.7 m. The mesh material is 3 mm expanded metal with 25.4 mm square openings. The screens are manually cleaned when required.

(d) Screening (cont'd)

The New intake well has two stationary screens, only one screen is used at any time. The screens are 2.18 m x 2.23 m. The mesh material is 4 mm diameter steel with 22 mm square openings. The screens are manually cleaned when required, which varies from once a day to several times a year.

(e) Low Lift Pumping

There is one concrete low lift suction chamber, 2.4 m x 10 m x 3.6 m deep. The following pumps are installed:

PUMP NO.	TYPE	POWER (kW)	CAPACITY (ML/d)
1	Electric	29.8	18.2
2	Electric	55.9	36.4
3	Electric	55.9	40.9
4	Electric	93.2	45.4
Standby	Diesel	93.2	26.5
Standby	Diesel	130.5	47.7
	TOTAL INSTALLED		215.1
	FIRM CAPACITY		167.4

It should be noted that the low lift pumping station cannot pump the firm capacity with normal lake levels and the pump discharge heads.

The raw water flow to the Old and New plants is controlled by two modulating butterfly valves, a 500 mm valve in the Old plant and a 600 mm valve in the New plant. The valve position is controlled by the settled water conduit level in each plant.

(f) Flash Mixing

There is no flash mixing at the Oshawa plant.

(g) Flocculation

All flocculation tanks are hydraulic spiral flow and are made of concrete. The water is introduced tangentially into each tank, and its momentum causes it to have a spiral flow pattern. Each cell contains wooden baffles which minimize localized flow eddies.

The flocculation tanks for the Old Plant consist of 12 tanks, 2.74 m x 2.74 m x 6.62 m deep each. The 12 tanks are arranged to provide three-stage flocculation in three sets of tanks (each set includes four tanks). All of the water flows through cells 1 and 2, and the flow then splits between cells 3 and 4. The total volume of the flocculation tanks is 596 m^3.

The water is introduced into the bottom of cell 1, has an upward spiral flow and exits at the top, is introduced into the top of cell 2, has a downward spiral flow and exits at the bottom, is introduced into the bottom of either cell 3 or 4, has an upward spiral flow and exits via two 300 mm x 300 mm openings in each cell into the settling tank. Each floc tank has a 150 mm diameter drain, and the floc tanks are manually cleaned twice a year when the settling tanks are cleaned.

Assuming a 27:87 split of flows between the Old and New Plants, and assuming the Old Plant flow splits evenly to the three sets of flocculation tanks, the flocculation detention times at 114 and 85 ML/d are 32 and 43 minutes, respectively, based on the total tank volume.

The flocculation tanks for the New Plant consist of 9 tanks, 4.82 m x 4.82 m x 6.25 m deep each. The 9 tanks are arranged to provide two-stage flocculation in three sets of tanks (each set includes three tanks). Each set feeds one settling basin. Raw water enters the middle cell of each set, and flows to either adjacent cell before entering a settling tank. The total volume of the flocculation tanks is 1307 m^3.

The water is introduced into the bottom of cell 1, has an upward spiral flow, exits at the top through four 375 mm diameter openings, flows down a shaft and is introduced into the bottom of either cell 2 or cell 3 through two openings per cell. The water has an upward spiral flow and exits from each cell via two 900 mm x 450 mm openings into the flocculated water conduit.

(g) Flocculation (cont'd)

Assuming a 27:87 split of flows between the Old and New Plants, and assuming the New Plant flow splits evenly between the three sets of flocculation tanks, the flocculation detention times at 114 and 85 ML/d are 22 and 29 minutes, respectively, based on the total tank volume.

The mixing velocity gradients in the flocculation tanks have been estimated based on a mixing energy input equivalent to the loss of momentum of the water entering the tanks. This is a conservative estimate of the total mixing, since other energy losses occur during passage of the water from one tank to another. This additional mixing energy could result in G values which are as much as 25 percent higher. The actual energy loss can be obtained from precise hydraulic tests.

Useful flocculation velocity gradients range from 100 to <10 sec^{-1}. A "tapered" or stepped series should be used; the highest mixing is provided initially, progressing through a series of cells of decreasing mixing levels. Additionally, the dimensionless parameter, Gt, which is the product of velocity gradient and the duration of mixing, is a most useful parameter which usually must have values within the range of 10^4 to 10^5.

Estimated Velocity Gradient at 10°C:

OLD PLANT Sets 1-2	27 ML/d	20 ML/d
Cell 1	$G = 58.5\ s^{-1}$	$G = 37.3\ s^{-1}$
Cell 2	$G = 17.9\ s^{-1}$	$G = 11.4\ s^{-1}$
Cell 3	$G = 11.3\ s^{-1}$	$G = 7.2\ s^{-1}$
Cell 4	$G = 8.0\ s^{-1}$	$G = 5.1\ s^{-1}$
Overall	$Gt = 4.5 \times 10^4$	$Gt = 3.9 \times 10^4$

Estimated Velocity Gradient at 10°C:

OLD PLANT Set 3	27 ML/d	20 ML/d
Cell 1	$G = 58.5\ s^{-1}$	$G = 37.3\ s^{-1}$
Cell 2	$G = 17.9\ s^{-1}$	$G = 11.4\ s^{-1}$
Cell 3 or 4	$G = 11.3\ s^{-1}$	$G = 7.2\ s^{-1}$
Overall	$Gt = 4.7 \times 10^4$	$Gt = 4.1 \times 10^4$

(g) Flocculation (cont'd)

Estimated Velocity Gradient at 10°C:

NEW PLANT	87 ML/d	65 ML/d
Cell 1	$G = 76.7\ s^{-1}$	$G = 49.6\ s^{-1}$
Cell 2 or 3	$G = 15.5\ s^{-1}$	$G = 10.0\ s^{-1}$
Overall	$Gt = 4.7 \times 10^4$	$Gt = 3.2 \times 10^4$

(h) Settling

The settling tanks are horizontal cross-flow and are made of concrete.

There are 3 tanks in the Old Plant. Two tanks are 24.7 m x 5.5 m x 6.6 m deep. The other tank is 25.3 m x 5.37 m x 6.6 m deep. The total volume and surface areas of the settling tanks are 2690 m^3 and 408 m^2, respectively. Assuming a 27:87 split of flows between the Old and New Plants, the settling detention times at 114 and 85 ML/d are 144 and 194 minutes, respectively, based on the total tank volume. For similar flow conditions, the overflow rates are 2.9 and 2.1 m/h, respectively.

The Old Plant flocculated water is introduced into each settling tank directly from the floc tanks via four 300 mm x 300 mm openings. Each port has a 900 mm x 900 mm timber target baffle. Each settling tank has two 400 mm diameter x 2.3 m long settled water collecting troughs which have a 110 mm x 1.68 m slot. The settled water is transported to the filters via a 750 mm diameter header.

There are 3 tanks in the New Plant. Two tanks, each measuring 25 m x 15 m x 4.9 m deep serve Filters 1-4. A tank 25 m x 15.85 m x 4.9 m deep serves Filters 5-6. The total volume and surface areas of the settling tanks are 5617 m^3 and 1146 m^2, respectively. Assuming a 27:87 split of flows between the Old and New Plants, the settling detention times at 114 and 85 ML/d are 93 and 124 minutes, respectively, based on the total tank volume. For similar flow conditions, the overflow rates are 3.2 and 2.4 m/h, respectively.

Each settling tank is fed from a flocculated water conduit via twelve 300 mm x 300 mm ports. Each port has a 900 mm x 900 mm timber target baffle. Each settling tank has six 350 mm diameter x 2.44 m long settled water collection troughs which have a 85 mm x 2 m slot.

(i) Filters

The Oshawa plant has 14 filters in total. The settled water is distributed from the settled water conduits to the filters via the washwater troughs. Filters 1-8 in the Old Plant are each 4.0 m x 6.2 m, and Filters 1-6 in the New Plant are each 12.8 m x 6.4 m. The total filtration area is 690 m^2.

All filters at the Oshawa plant are dual media and have surface agitators. The New Plant filters have BIF constant rate controllers with a clearwell level override. The Old Plant filters have Keystone control valves which do not modulate automatically. The valve position must be manually adjusted, and the filters may often operate in a declining rate. There is a clearwell level alarm to alert the operators to manually decrease the Old Plant filtration rate.

All filter boxes are constructed of concrete. The filters in the Old Plant have cast iron lateral underdrains, and the filters in the New Plant have Leopold block underdrains.

(i) Filters (cont'd)

FILTERS 1-8 (1930)

	L (m)	W (m)	(1) D (m)	SURFACE AREA (m^2)
Each Filter	4.0	6.2	1.8	24.8
8 Filters	-	-	-	198.4

Notes:

(1) D(m) is depth of water in filter box in metres.
Filter 1 and 2 have cast iron lateral underdrains.
Filters 3-8 have cast iron lateral underdrains.
The approximate filter media make up is as follows:

	Depth (m)
Anthracite	0.30
Sand	0.60
Gravel and Drains	0.30
	1.20

(i) Filters (cont'd)

NEW PLANT, FILTERS 1-2 (1953), FILTERS 3-4 (1960), FILTERS 5-6 (1965)

	L (m)	W (m)	(1) D (m)	SURFACE AREA (m^2)
Each Filter	12.8	6.4	2.1	81.9
6 Filters	-	-	-	491.4

Notes:

(1) D(m) is depth of water in filter box in metres.

Filters 1 and 2 have cast iron lateral underdrains.

Filters 3-6 have Leopold block underdrains.

The approximate filter media make up is as follows:

	PARTICLE SIZE (mm)	DEPTH (m)
Anthracite		0.305
Sand #2	0.35 - 1.4	0.407
Sand #1	1.19 - 2.39	0.051
Gravel #4	4.75 - 6.35	0.076
Gravel #3	6.35 - 12.7	0.076
Gravel #2	12.7 - 25.4	0.102
Gravel #1	25.4 - 38.1	0.204

(i) Filters (cont'd)

Raw Water Turbidity Range (NTU)	0.24 - 75 Based on bi-hourly readings obtained by the operator taking raw water with the laboratory Hach Ratio Turbidimeter.
Effluent Turbidity Range (NTU)	0.05 - 1.30 Based on bi-hourly readings obtained by the operator taking plant effluent grab samples and measuring the turbidity with a laboratory Hach Ratio Turbidimeter.
Length of Run	24 - 60 hours, depending on raw water quality. A filter will also be backwashed if the headloss reaches 1.8 m, or if turbidity breakthrough occurs.
Headloss (Clean bed/dirty bed)	0.25 - 1.8 m

Flow Rate

Total Flow (ML/d)	Split Flow (ML/d)	Filtration Rate			
		Plant 1	Plant 2		
		1-8	1-2*	3-4*	5-6*
114	27/87	5.7 m/h	6.9 m/h	6.5 m/h	8.8 m/h
85	20/65	4.2 m/h	5.1 m/h	4.8 m/h	6.6 m/h

Backwash Flow	Old Plant	One Rate	28.2 m/h
	New Plant	Low	9.3 m/h
		High	23.2 m/h

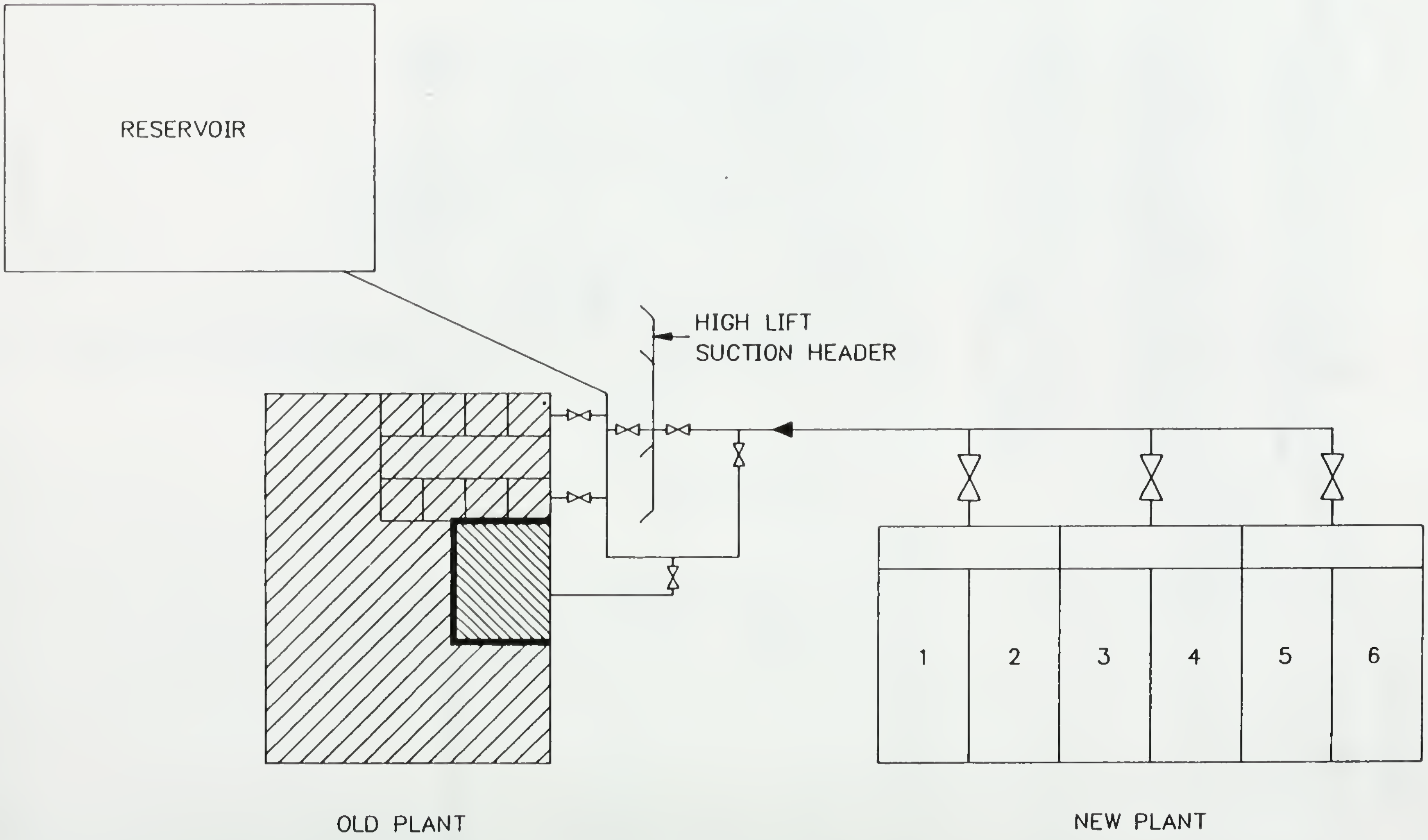
Backwash Water/Wash	Old Plant	4.6 - 5.6 m^3/m^2 range
	New Plant	3.0 - 3.5 m^3/m^2 range

---

* Based on maximum filtration rates of 13.6 ML/d for Filters 1-2, 12.7 ML/d for Filters 3-4, and 17.2 ML/d for Filters 5-6.

FIGURE 2

CLEARWELL AND RESERVOIR CONNECTIONS
FLOW SCHEMATIC



(i) Filters (cont'd)

The filter backwash system at the Oshawa plant consists of one 72.6 ML/d Allis Chalmers electric pump (head = 10.7 m). The pump draws water from the clearwell under Filters 5-6 in the New Plant. If the pump is out of service for any reason, it is possible to use flow from the high lift discharge to wash the filters.

The backwash procedure for the New Plant is outlined in Appendix B and is an automatic system, activated by the operator. The backwash rates are ramped to their values. The Old Plant filters are manually backwashed. The backwash rates are not ramped. Following a wash, filter to waste is not practiced at the Oshawa plant.

All filters are equipped with surface agitators, which, in general, operate at flows of 1.8 m/h at the plant service water pressure.

(j) Clearwells

There are five clearwells and a reservoir at the Oshawa Water Supply Plant. All are constructed of concrete.

Clearwell under Old Plant	0.454 ML
Clearwell under Old Plant	1.816 ML
Clearwell under New Plant, Filters 1-2	1.362 ML
Clearwell under New Plant, Filters 3-4	1.362 ML
Clearwell under New Plant, Filters 5-6	0.658 ML
Reservoir	4.54 ML
	10.2 ML

The transmission of water between the clearwells and reservoir is shown in Figure 2 on the opposite page.

(k) High Lift Pumping

The high lift pumping station contains seven (7) high lift pumps. All pumps are horizontal centrifugal, five have electric motors and two have diesel engines. The diesel pumps are run once a week as a maintenance routine.

PUMP NO.	TYPE	CAPACITY ML/d	HEAD (m)	POWER (kW)
3	Electric	15.9	94.5	224
4	Electric	13.6	97.6	186
5	Electric	31.8	97.6	447
6	Electric	31.8	97.6	447
7	Electric	31.8	97.6	447
Standby	Diesel	34.6	97.6	522
Standby	Diesel	24.9	91.5	358

Total Installed	184.4
Firm Capacity	149.8

The firm capacity assumes the loss of the largest pump.

(l) Backwash Treatment

Presently, the plant has no waste treatment facilities. The backwash water is drained back to Lake Ontario.

(m) Sludge Disposal

The settling tank sludge is also drained into Lake Ontario. The tanks are manually cleaned twice a year. Portable pumps discharge the sludge to the shoreline of the lake at the south end of the plant.

C.3 Chemical Systems

(a) Disinfectant

Chlorine is stored as a liquid in 0.9 tonne cylinders. The chlorine storage room is located at the south end of the plant, in the low lift area. The storage room has space for 14 one-tonne cylinders. Oshawa normally has the four active cylinders plus a maximum of six standby cylinders on hand at any time.

Application points:

Pre-	Low lift suction well
Post-	High lift discharge

Equipment:

Pre-	2 - 909 kg/d Wallace & Tiernan gas chlorinators 2 - 180 kg/d rotameters 1 - continuous chlorine analyzer
Post-	2 - 909 kg/d Wallace & Tiernan gas chlorinators 1 - 68 kg/d rotameter 1 - 34 kg/d rotameter 1 - continuous chlorine analyzer for compound loop control of chlorine feed based on chlorine residual

The pre-chlorine dosage is flow paced on the raw water flow signal, and is manually adjusted to obtain a free chlorine residual of 0.8 to 1.0 mg/L on the low lift discharge or approximately 0.6 to 0.7 mg/L on top of the filters. The post-chlorine dosage is flow paced on the respective treated water flow signals and is residual controlled (compound loop). A free chlorine residual of 0.5 to to 0.6 mg/L is maintained in the high lift discharge, as measured by a Wallace & Tiernan continuous chlorine analyzer.

The combined total chlorine feed rate of 462 kg/d results in a maximum dosage of 4.1 and 5.4 mg/L for 114 and 85 ML/d, respectively.

(b) Coagulant

Liquid alum is stored in a PVC-lined wood stave storage tank. The capacity of the tank is 59,000 L.

Alum is fed directly from the storage tank with a diaphragm metering pump. There are two Wallace & Tiernan Model 44-115 metering pumps, one is a standby. The metering pumps have a manual stroke adjustment, and the speed is flow paced from the raw water flow signal. Each pump has a maximum capacity of 9463.5 L/day. The maximum dosage capacity, if both pumps were operating, is 108 and 145 mg/L for 114 and 85 ML/d, respectively.

At the time of this investigation, alum was added directly into the suction of low lift pumps No. 3 or 4. During the period studied, the alum dosage varied from 0.1 to 105 mg/L.

(c) Fluoride

Fluoride is added in the form of hydrofluosilicic acid. The acid is stored in a 24,500 L PVC-lined wood stave tank.

Fluoride is fed directly from the storage tank with a diaphragm metering pump. The pump is a Wallace & Tiernan Model 44-113 metering pump. The metering pump has a manual stroke adjustment, and the speed of the metering pump is flow paced from the raw water flow signal. The maximum capacity of the metering pump is 1893 L/d, which corresponds to a maximum dosage capacity of 4.0 and 5.3 mg/L F^- for 114 and 85 ML/d, respectively.

The application point is in the low lift suction well. During the period studied, the fluoride dosage varied from 0.5 to 6.1 mg/L, with monthly average dosages of 1.1 to 1.89 mg/L. The 6.1 mg/L dosage may have been a result of inaccurate fluoride tank level measurements. The monthly average residual ranged from 1.06 to 1.21 mg/L F^-.

Both fluoride and alum are added into the low lift suction well. It has been speculated that alum may consume part of the fluoride dosage. The appropriateness of adding these chemicals together should be investigated.

(c) Fluoride (cont'd)

The Regional staff have identified the fluoride system as an area of concern due to the occurrence of etching in glass and plastics in the vicinity. To date, the Region has not been able to locate equipment to measure the ambient fluoride concentration levels. The Region is continuing to investigate this matter.

C.4 Drawings

(a) Site Plan

Following is a site plan of the Oshawa Water Supply Plant.

(b) Process and Piping Diagram

A process flow and piping diagram was not available from the record drawings.

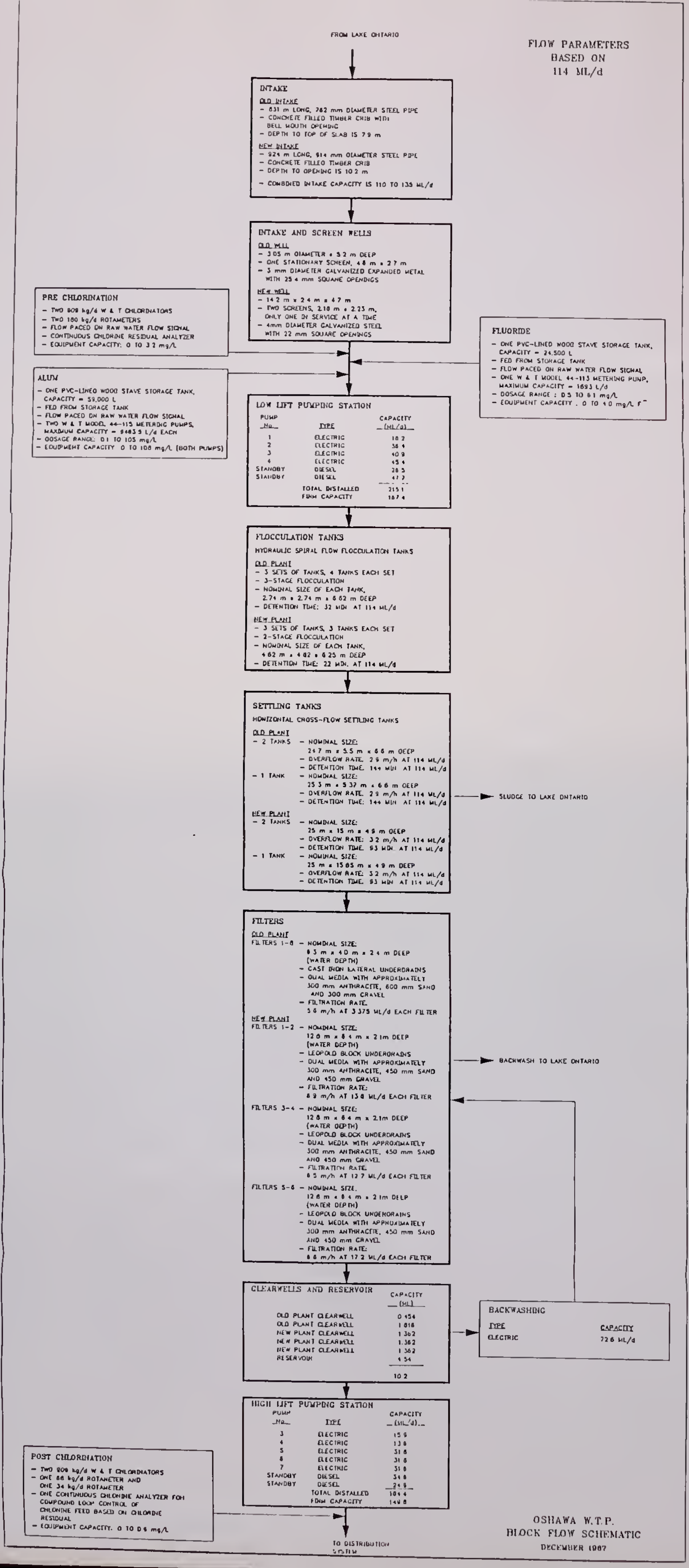
(c) Block Schematic

Following is a block flow diagram of the Oshawa Plant.

(d) Photographs

Following is a series of photographs to illustrate major components and chemical feed systems.

FLOW PARAMETERS
BASED ON
114 ML/d



FROM LAKE ONTARIO

INTAKE

OLD INTAKE
- 831 m LONG, 762 mm DIAMETER STEEL PIPE
- CONCRETE FILLED TIMBER CRIB WITH BELL MOUTH OPENING
- DEPTH TO TOP OF SLAB IS 7.9 m

NEW INTAKE
- 924 m LONG, 914 mm DIAMETER STEEL PIPE
- CONCRETE FILLED TIMBER CRIB
- DEPTH TO OPENING IS 10.2 m

- COMBINED INTAKE CAPACITY IS 110 TO 135 ML/d

INTAKE AND SCREEN WELLS

OLD WELL
- 3.05 m DIAMETER x 5.2 m DEEP
- ONE STATIONARY SCREEN, 4.8 m x 2.7 m
- 3 mm DIAMETER GALVANIZED EXPANDED METAL WITH 25.4 mm SQUARE OPENINGS

NEW WELL
- 14.2 m x 2.4 m x 4.7 m
- TWO SCREENS, 2.18 m x 2.23 m, ONLY ONE IN SERVICE AT A TIME
- 4mm DIAMETER GALVANIZED STEEL WITH 22 mm SQUARE OPENINGS

PRE CHLORINATION
- TWO 909 kg/d W & T CHLORINATORS
- TWO 180 kg/d ROTAMETERS
- FLOW PACED ON RAW WATER FLOW SIGNAL
- CONTINUOUS CHLORINE RESIDUAL ANALYZER
- EQUIPMENT CAPACITY: 0 TO 3.2 mg/L

ALUM
- ONE PVC-LINED WOOD STAVE STORAGE TANK, CAPACITY = 59,000 L
- FED FROM STORAGE TANK
- FLOW PACED ON RAW WATER FLOW SIGNAL
- TWO W & T MODEL 44-115 METERING PUMPS, MAXIMUM CAPACITY = 9483.5 L/d EACH
- DOSAGE RANGE: 0.1 TO 105 mg/L
- EQUIPMENT CAPACITY 0 TO 108 mg/L (BOTH PUMPS)

FLUORIDE
- ONE PVC-LINED WOOD STAVE STORAGE TANK, CAPACITY = 24,500 L
- FED FROM STORAGE TANK
- FLOW PACED ON RAW WATER FLOW SIGNAL
- ONE W & T MODEL 44-113 METERING PUMP, MAXIMUM CAPACITY = 1693 L/d
- DOSAGE RANGE : 0.5 TO 6.1 mg/L
- EQUIPMENT CAPACITY . 0 TO 4.0 mg/L F^-

LOW LIFT PUMPING STATION

PUMP No.	TYPE	CAPACITY (ML/d)
1	ELECTRIC	18.2
2	ELECTRIC	34.4
3	ELECTRIC	40.9
4	ELECTRIC	45.4
STANDBY	DIESEL	28.5
STANDBY	DIESEL	47.7
	TOTAL INSTALLED	215.1
	FIRM CAPACITY	167.4

FLOCCULATION TANKS

HYDRAULIC SPIRAL FLOW FLOCCULATION TANKS

OLD PLANT
- 3 SETS OF TANKS, 4 TANKS EACH SET
- 3-STAGE FLOCCULATION
- NOMINAL SIZE OF EACH TANK, 2.74 m x 2.74 m x 6.62 m DEEP
- DETENTION TIME: 32 MIN AT 114 ML/d

NEW PLANT
- 3 SETS OF TANKS, 3 TANKS EACH SET
- 2-STAGE FLOCCULATION
- NOMINAL SIZE OF EACH TANK, 4.62 m x 4.62 x 6.25 m DEEP
- DETENTION TIME: 22 MIN. AT 114 ML/d

SETTLING TANKS

HORIZONTAL CROSS-FLOW SETTLING TANKS

OLD PLANT
- 2 TANKS
  - NOMINAL SIZE: 24.7 m x 5.5 m x 6.6 m DEEP
  - OVERFLOW RATE. 2.9 m/h AT 114 ML/d
  - DETENTION TIME. 144 MIN AT 114 ML/d
- 1 TANK
  - NOMINAL SIZE: 25.3 m x 5.37 m x 6.6 m DEEP
  - OVERFLOW RATE. 2.9 m/h AT 114 ML/d
  - DETENTION TIME: 144 MIN AT 114 ML/d

NEW PLANT
- 2 TANKS
  - NOMINAL SIZE: 25 m x 15 m x 4.9 m DEEP
  - OVERFLOW RATE: 3.2 m/h AT 114 ML/d
  - DETENTION TIME. 93 MIN. AT 114 ML/d
- 1 TANK
  - NOMINAL SIZE: 25 m x 15.65 m x 4.9 m DEEP
  - OVERFLOW RATE: 3.2 m/h AT 114 ML/d
  - DETENTION TIME. 93 MIN AT 114 ML/d

SLUDGE TO LAKE ONTARIO

FILTERS

OLD PLANT
- FILTERS 1-8
  - NOMINAL SIZE: 8.3 m x 4.0 m x 2.4 m DEEP (WATER DEPTH)
  - CAST IRON LATERAL UNDERDRAINS
  - DUAL MEDIA WITH APPROXIMATELY 300 mm ANTHRACITE, 600 mm SAND AND 300 mm GRAVEL
  - FILTRATION RATE. 5.6 m/h AT 3.375 ML/d EACH FILTER

NEW PLANT
- FILTERS 1-2
  - NOMINAL SIZE: 12.8 m x 8.4 m x 2.1m DEEP (WATER DEPTH)
  - LEOPOLD BLOCK UNDERDRAINS
  - DUAL MEDIA WITH APPROXIMATELY 300 mm ANTHRACITE, 450 mm SAND AND 450 mm GRAVEL
  - FILTRATION RATE: 8.9 m/h AT 13.8 ML/d EACH FILTER
- FILTERS 3-4
  - NOMINAL SIZE: 12.8 m x 8.4 m x 2.1m DEEP (WATER DEPTH)
  - LEOPOLD BLOCK UNDERDRAINS
  - DUAL MEDIA WITH APPROXIMATELY 300 mm ANTHRACITE, 450 mm SAND AND 450 mm GRAVEL
  - FILTRATION RATE. 8.5 m/h AT 12.7 ML/d EACH FILTER
- FILTERS 5-6
  - NOMINAL SIZE. 12.8 m x 8.4 m x 2.1m DEEP (WATER DEPTH)
  - LEOPOLD BLOCK UNDERDRAINS
  - DUAL MEDIA WITH APPROXIMATELY 300 mm ANTHRACITE, 450 mm SAND AND 450 mm GRAVEL
  - FILTRATION RATE: 8.8 m/h AT 17.2 ML/d EACH FILTER

BACKWASH TO LAKE ONTARIO

CLEARWELLS AND RESERVOIR

	CAPACITY (ML)
OLD PLANT CLEARWELL	0.454
OLD PLANT CLEARWELL	1.818
NEW PLANT CLEARWELL	1.362
NEW PLANT CLEARWELL	1.362
NEW PLANT CLEARWELL	1.362
RESERVOIR	4.54
	10.2

BACKWASHING

TYPE	CAPACITY
ELECTRIC	72.6 ML/d

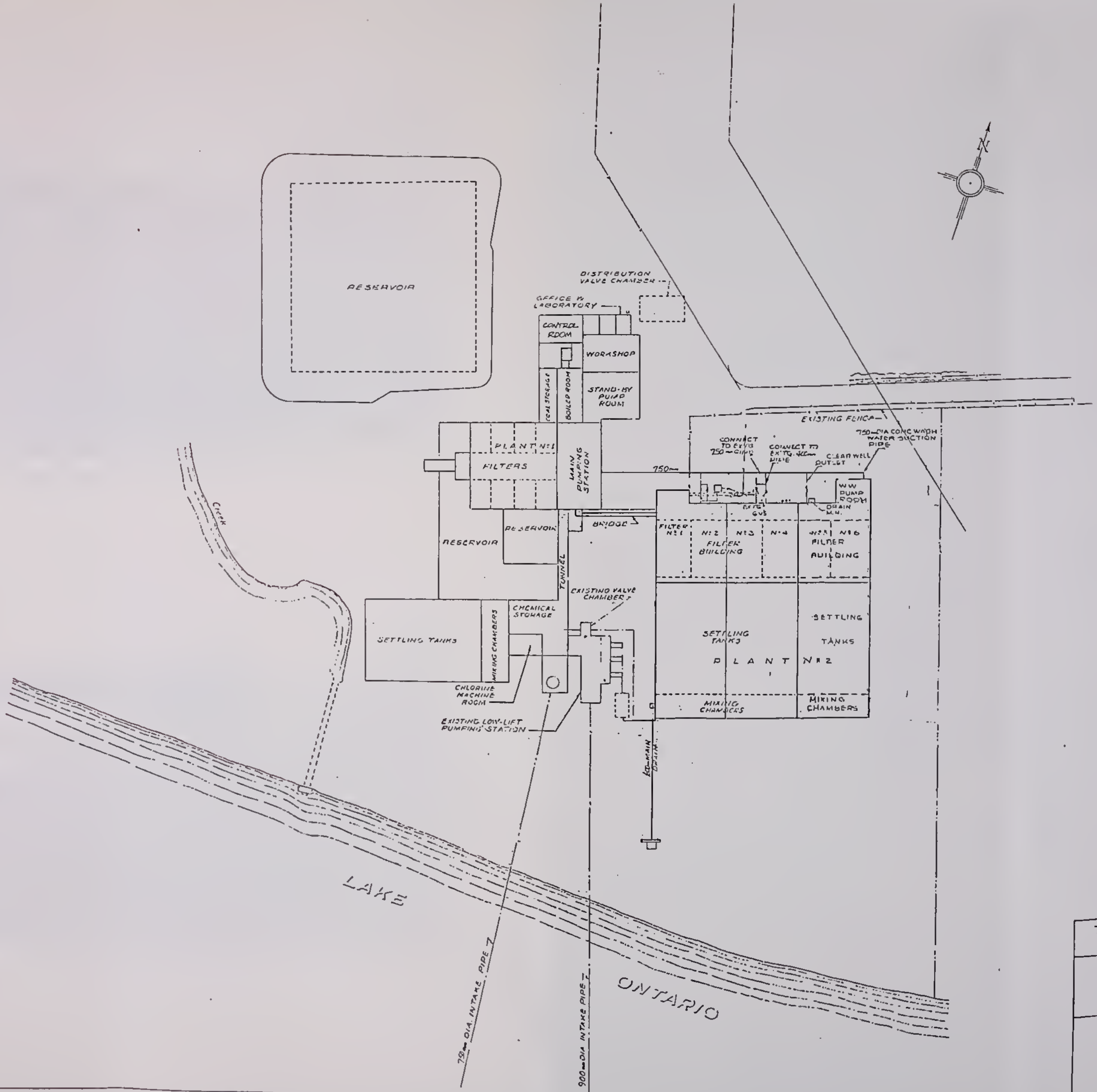
HIGH LIFT PUMPING STATION

PUMP No.	TYPE	CAPACITY (ML/d)
3	ELECTRIC	15.9
4	ELECTRIC	13.6
5	ELECTRIC	31.8
6	ELECTRIC	31.8
7	ELECTRIC	31.8
STANDBY	DIESEL	34.8
STANDBY	DIESEL	24.9
	TOTAL INSTALLED	184.4
	FIRM CAPACITY	149.6

POST CHLORINATION
- TWO 909 kg/d W & T CHLORINATORS
- ONE 68 kg/d ROTAMETER AND ONE 34 kg/d ROTAMETER
- ONE CONTINUOUS CHLORINE ANALYZER FOR COMPOUND LOOP CONTROL OF CHLORINE FEED BASED ON CHLORINE RESIDUAL
- EQUIPMENT CAPACITY. 0 TO 0.6 mg/L

TO DISTRIBUTION SYSTEM

OSHAWA W.T.P.
BLOCK FLOW SCHEMATIC
DECEMBER 1987



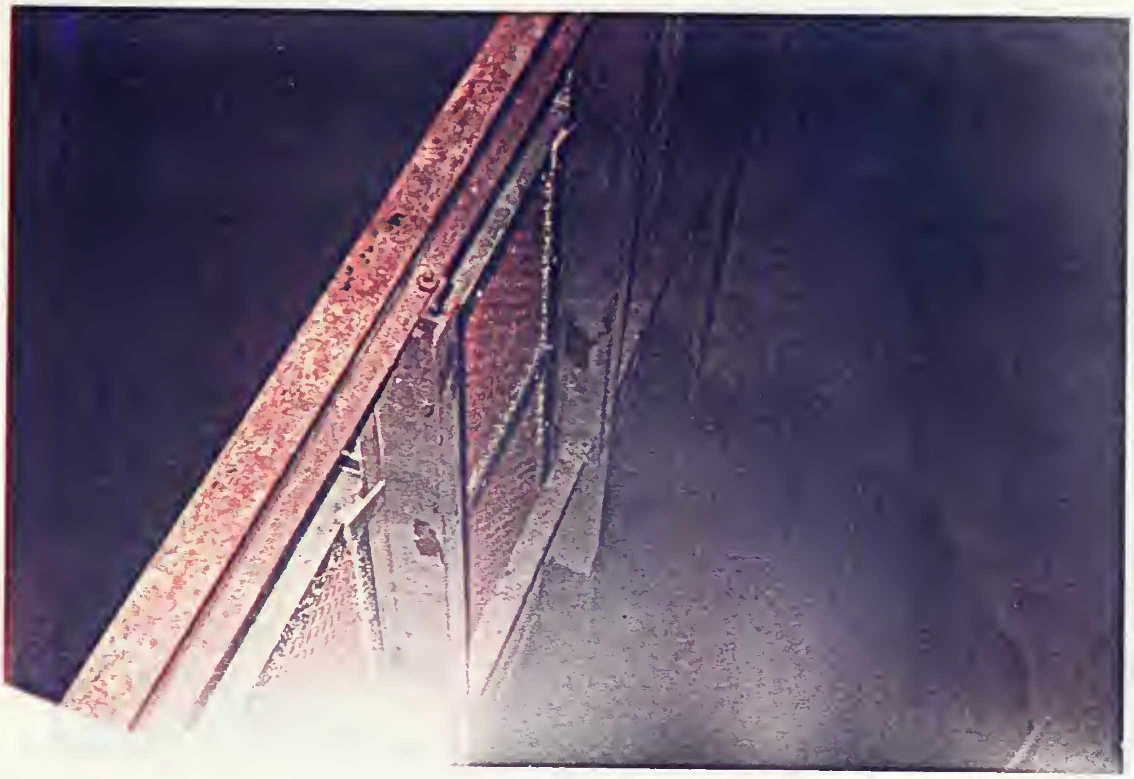
THE REGIONAL MUNICIPALITY OF DURHAM
WORKS DEPARTMENT

OSHAWA WATER FILTRATION PLANT

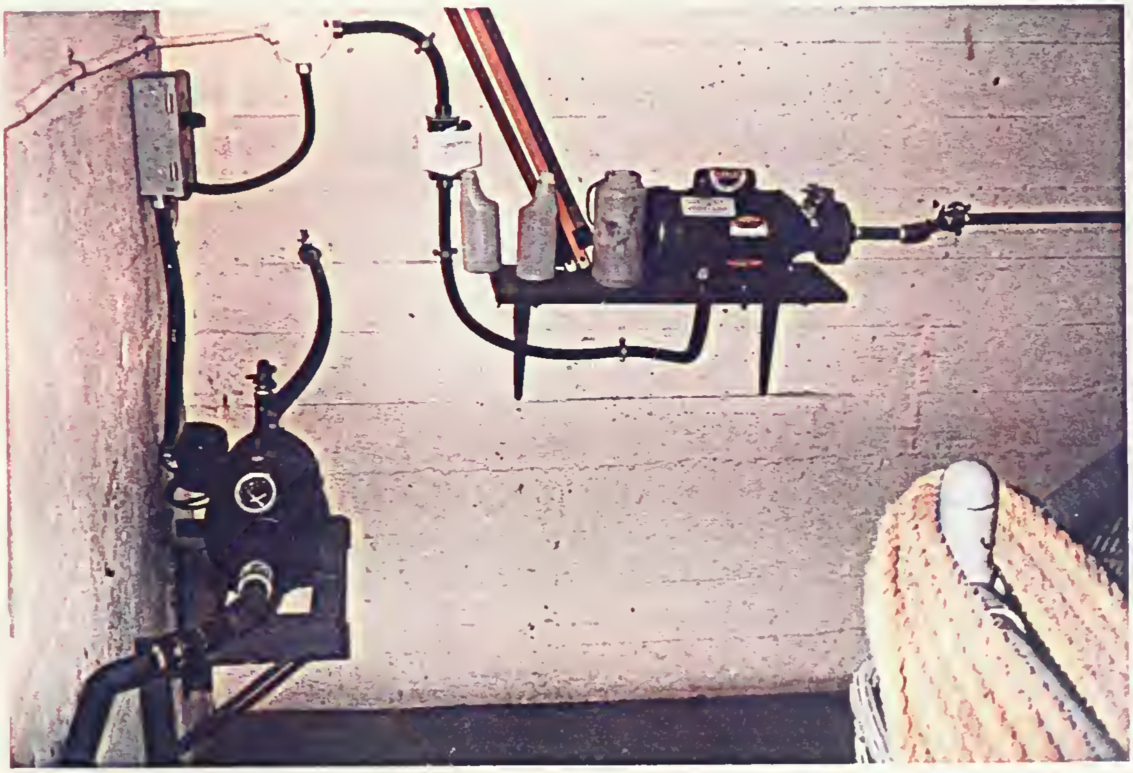
SITE PLAN

ADMINISTRATION BUILDING

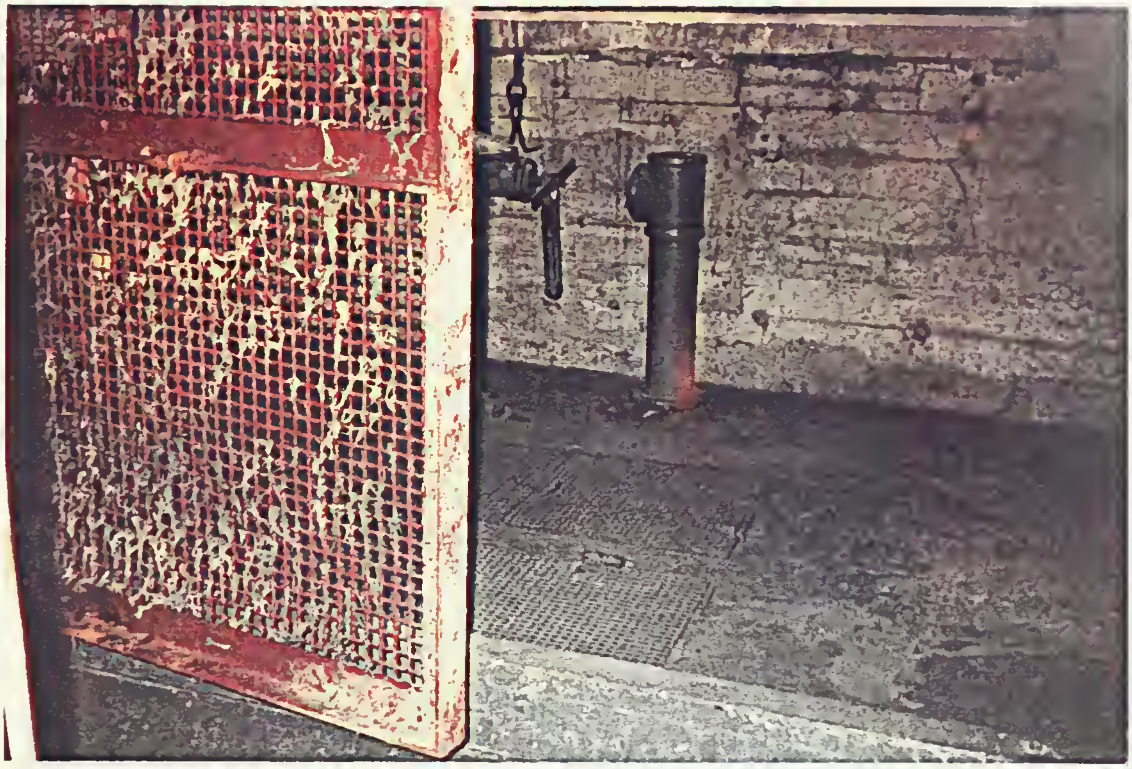
FILTER BUILDING (NEW PLANT)



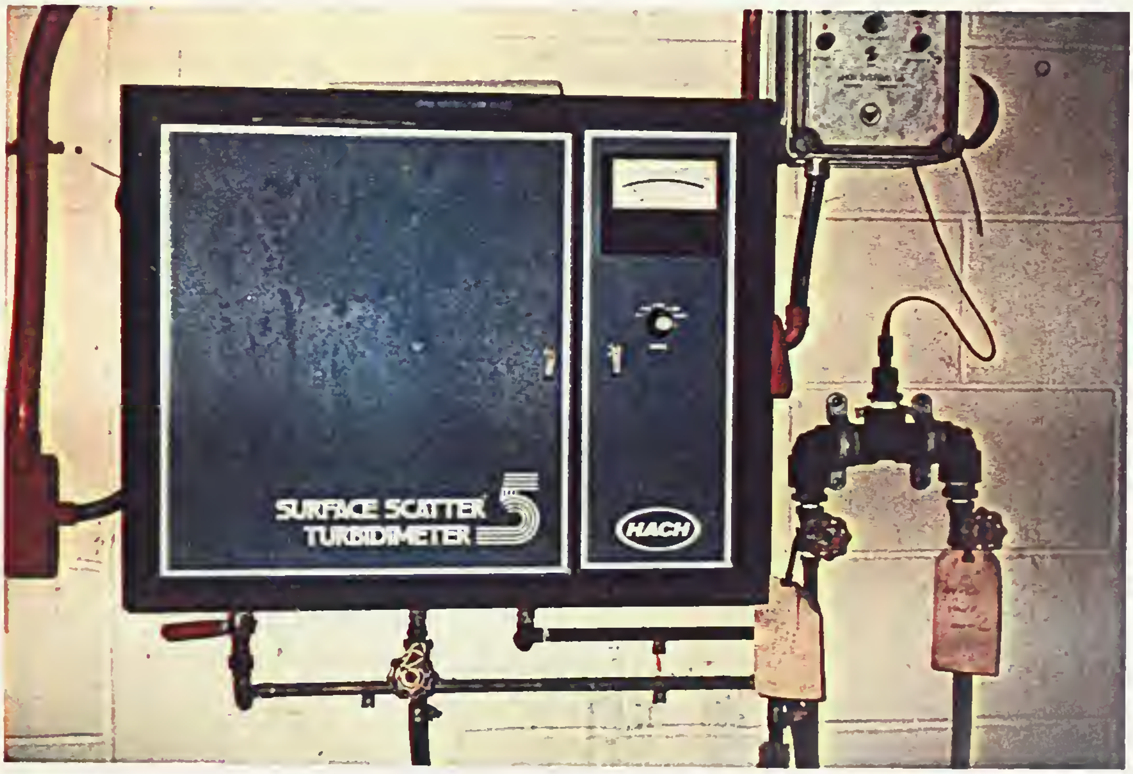
INTAKE WELL (OLD PLANT)



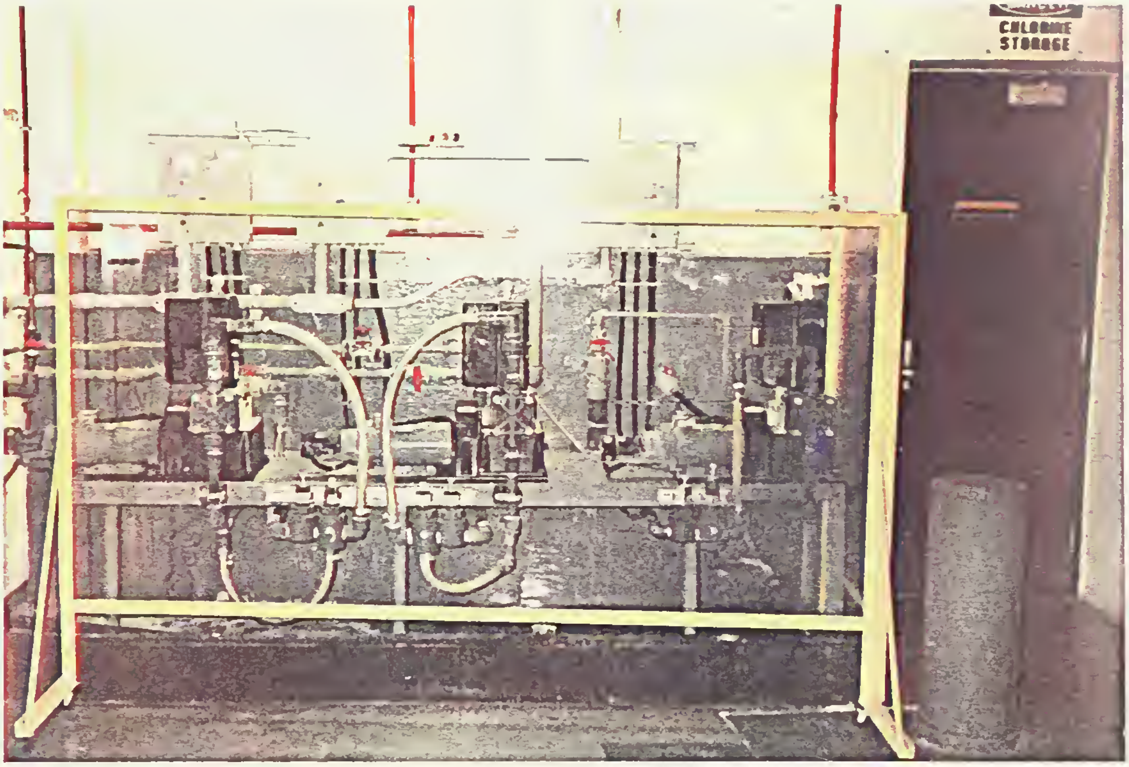
RAW WATER SAMPLING PUMPS (OLD PLANT)



INTAKE WELL (NEW PLANT)



RAW WATER TURBIDIMETER



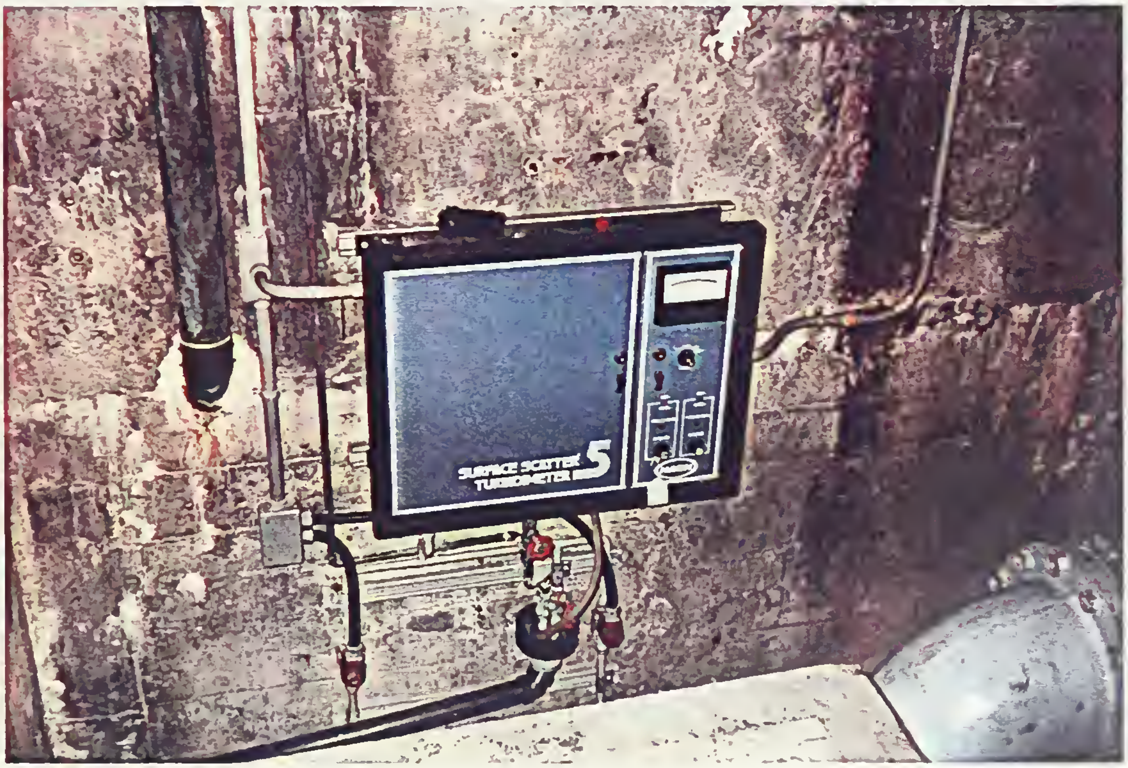
ALUM AND FLUORIDE METERING PUMPS

ALUM AND FLUORIDE STORAGE TANKS

LOW LIFT PUMPS

FLOCCULATION AND SEDIMENTATION TANKS (OLD PLANT)

FLOCCULATION AND SEDIMENTATION TANKS (NEW PLANT)



SETTLED WATER TURBIDIMETER

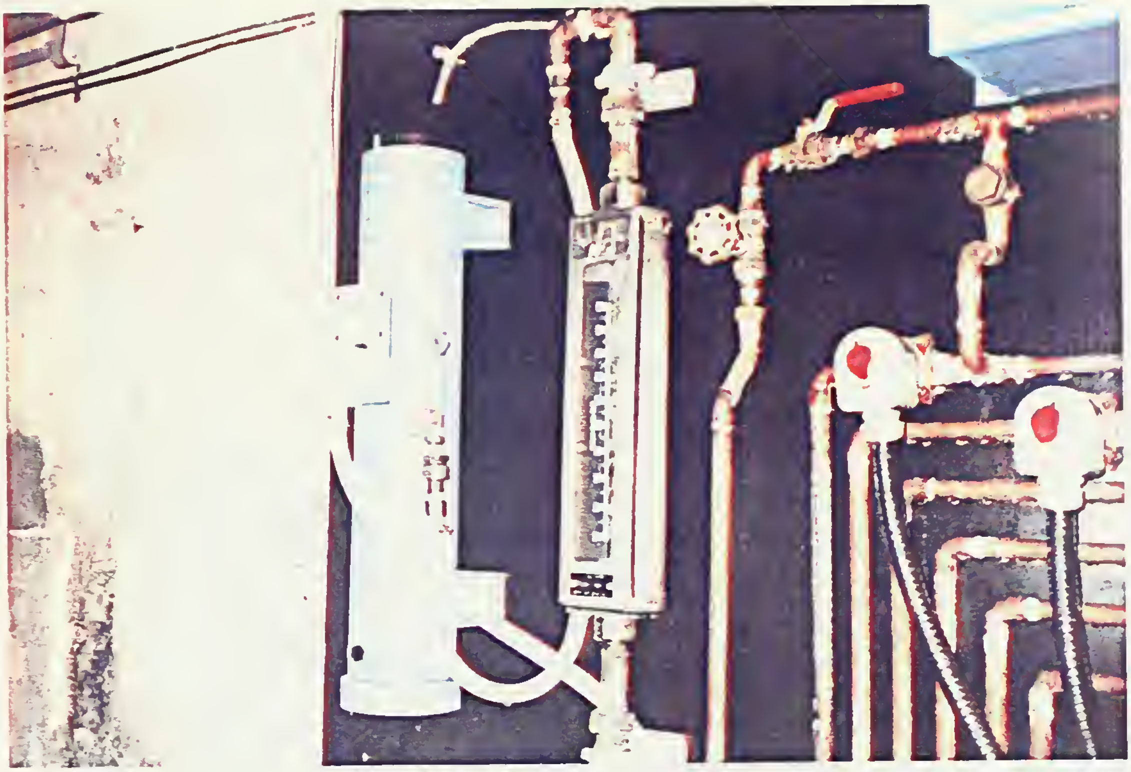
FILTER GALLERY (OLD PLANT)

FILTER GALLERY (NEW PLANT)

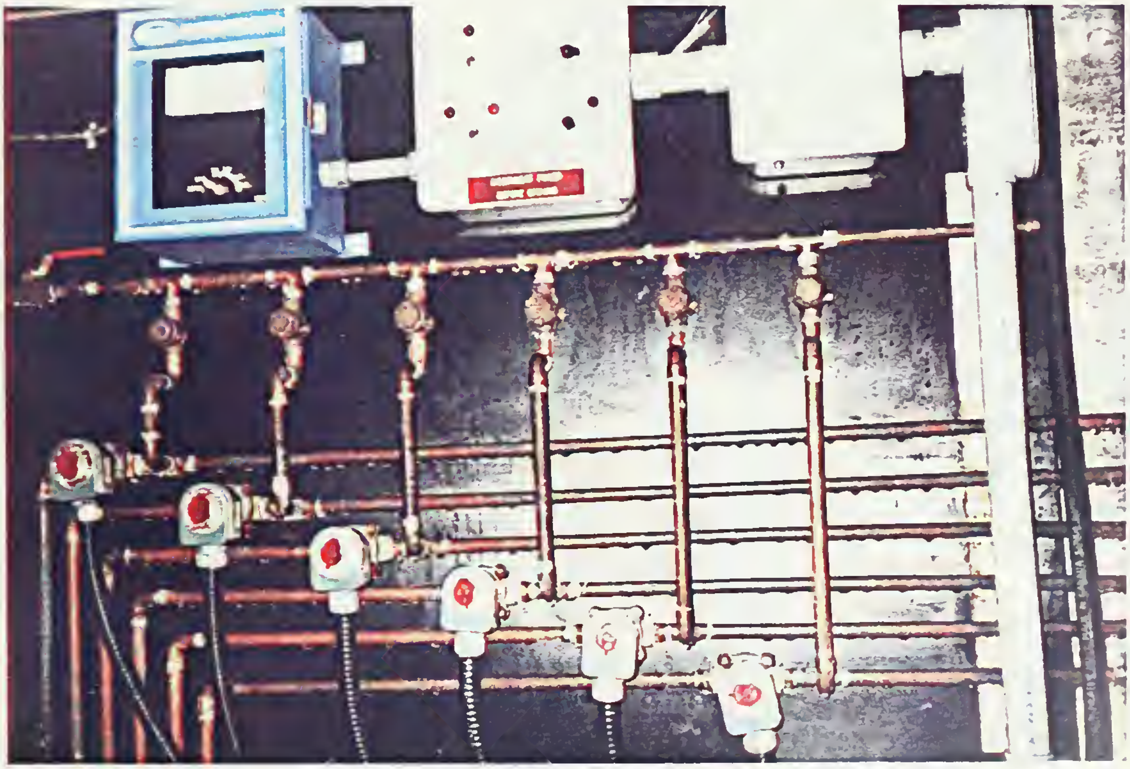
[illegible]

[illegible]

PIPE GALLERY (NEW PLANT)

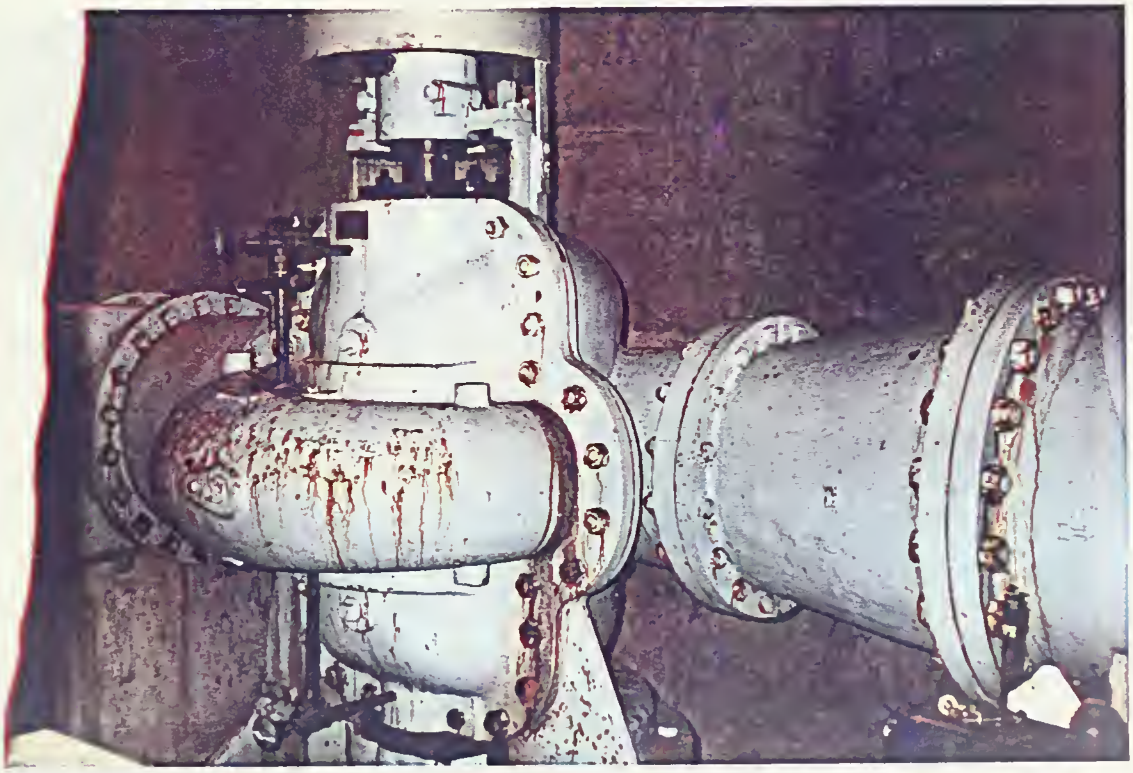


FILTER EFFLUENT TURBIDIMETER

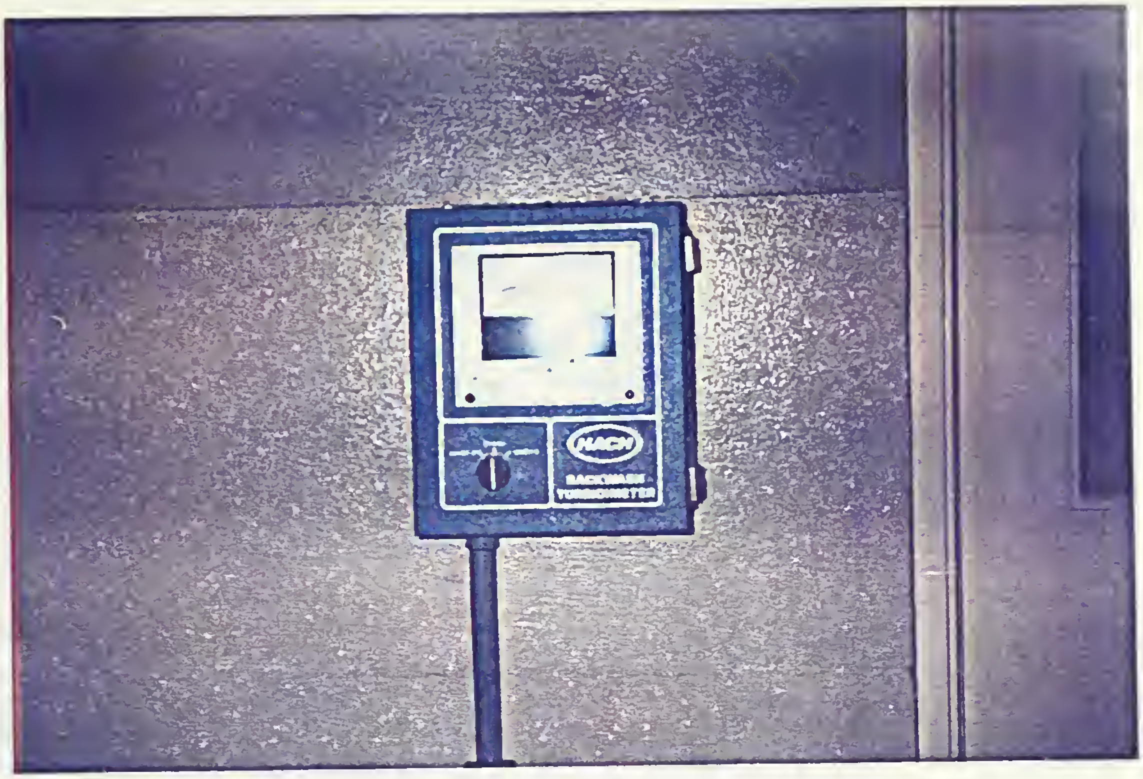


SAMPLING LINES FROM FILTERS 1-6 (NEW PLANT) TO TURBIDIMETER

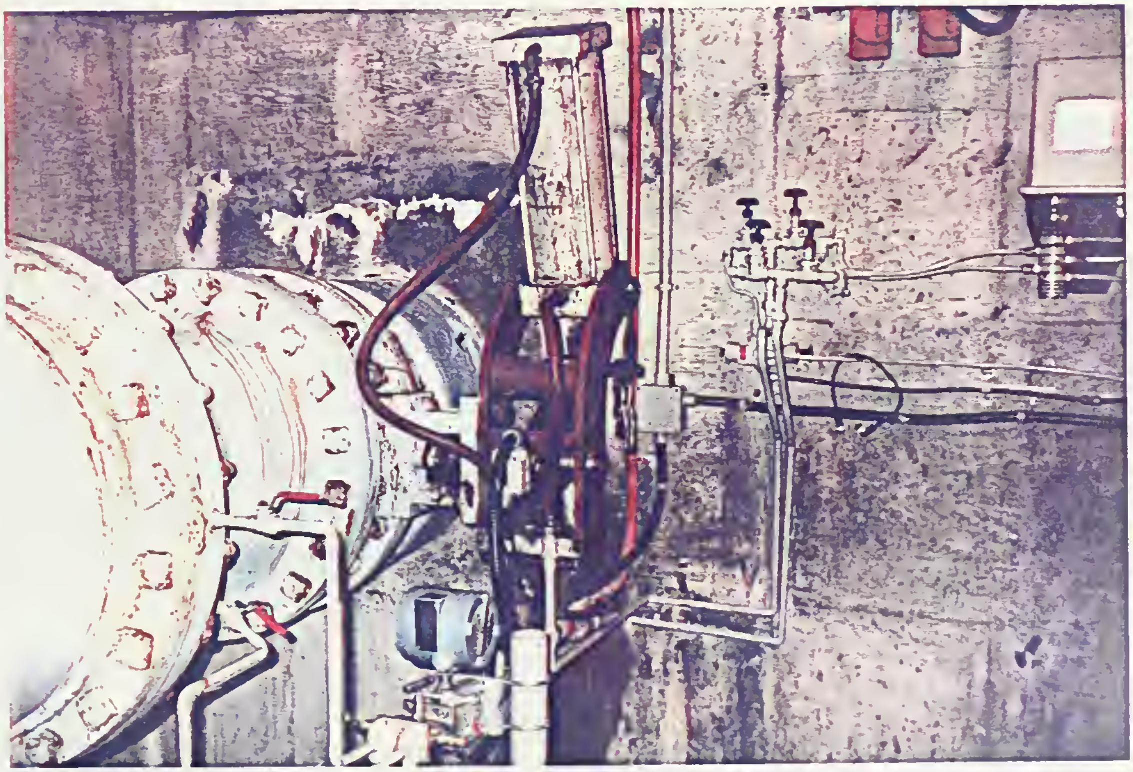
BACKWASH PUMP MOTOR



BACKWASH PUMP



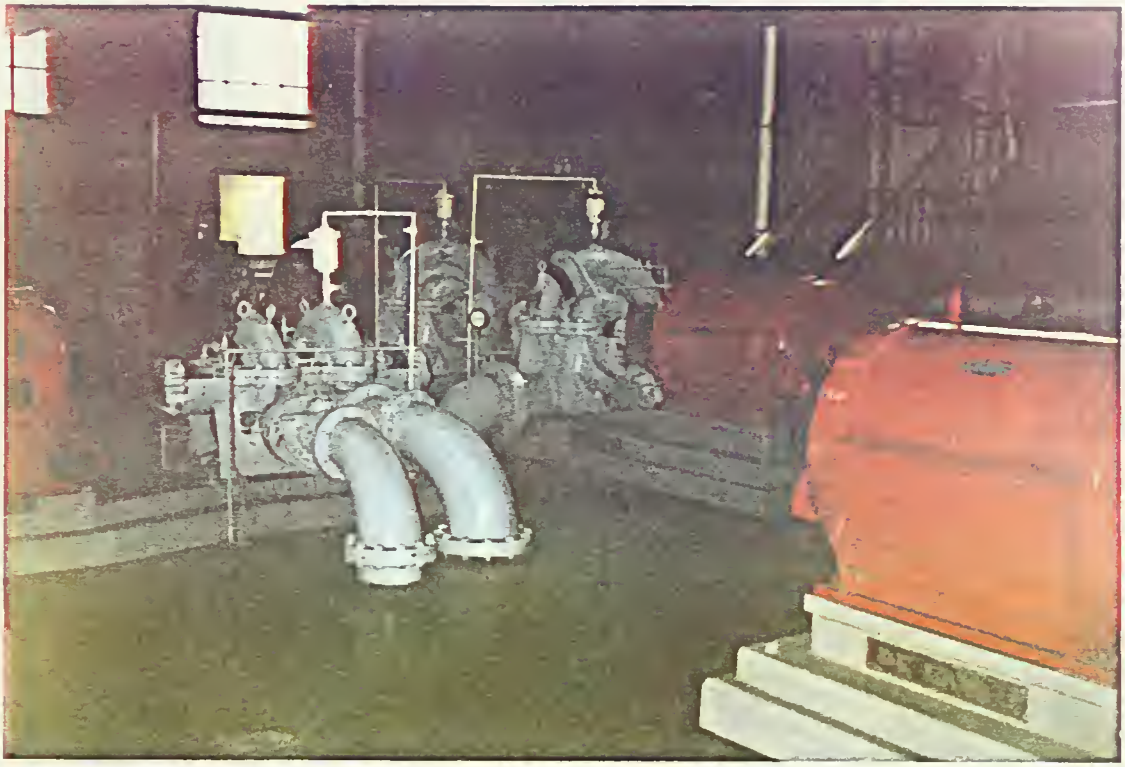
BACKWASH WATER TURBIDITY



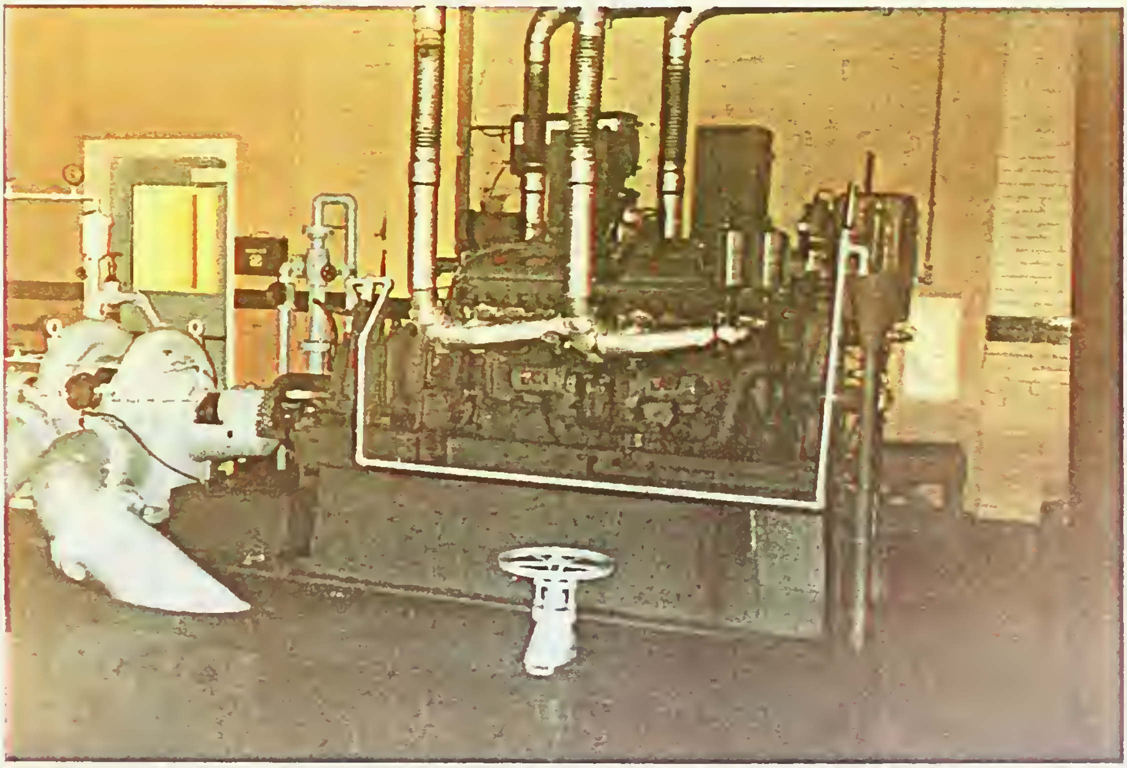
BACKWASH FLOW METER

CHLORINATORS

CHLORINE STORAGE



HIGH LIFT PUMPS



HIGH LIFT DIESEL PUMP

CONTROL ROOM

OPERATOR'S LAB

RESERVOIR

SECTION D

PLANT OPERATION

SECTION D
PLANT OPERATION

D.1 Plant Operation

(a) General

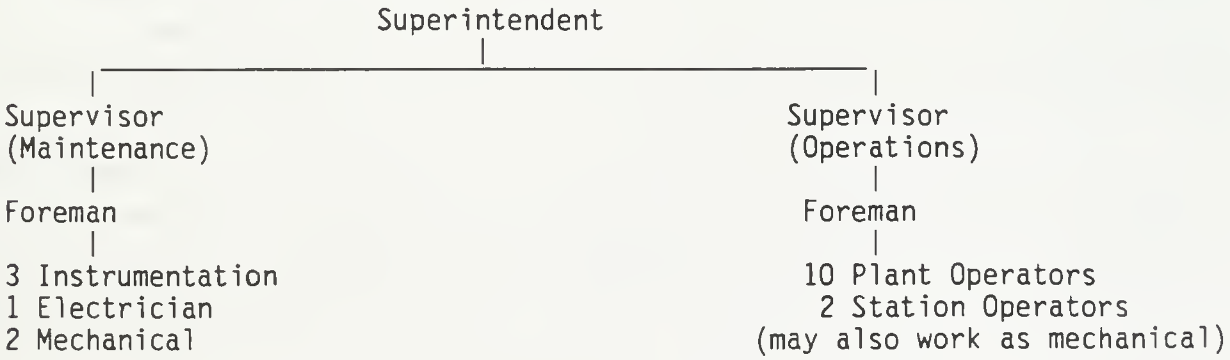
The Old Plant, containing 8 filters, was built in 1931. The New Plant was added in several stages; Filters 1-2 in 1953, Filters 3-4 in 1960, and Filters 5-6 in 1965.

A computer system has recently been integrated into the Oshawa plant. The system provides computerized supervisor control, data acquisition and maintenance control. It monitors the process, supply and distribution of water from the Oshawa, Ajax, and Whitby plants. If the computer system should crash, a backup computer system would be activated by the operator.

The computer contains a large database of plant operating data. At anytime, this data may be accessed and operating summaries generated. Computer printouts of various operating summaries are included in Appendix G.

(b) Personnel

The Oshawa plant has a total of 23 staff, who have various levels of responsibility. The Oshawa Plant is manned 24 hours a day. The chart below is a breakdown of the plant staff.



Superintendent

Supervisor
(Maintenance)

Foreman

3 Instrumentation
1 Electrician
2 Mechanical

Supervisor
(Operations)

Foreman

10 Plant Operators
2 Station Operators
(may also work as mechanical)

(b) Personnel (cont'd)

The operators at the Oshawa plant undergo various training programs. All operators attend the Ministry of the Environment training seminars; the Oshawa plant staff conduct in-house training programs; the suppliers of new equipment hold training demonstrations; and there are several introductory training seminars on video at the plant.

(c) Flow Control

RAW WATER

The Old and New Plants are fed raw water via two modulating raw water control valves. The two control valves adjust flow to maintain the settled water levels within a 225 mm band.

PRE-TREATMENT AND SEDIMENTATION

All of the flocculation and sedimentation tanks are used all of the time, except during the cleaning of the tanks.

FILTRATION

All of the filters are usually operated all of the time. The Oshawa plant is the base plant for the integrated water supply system serving Oshawa, Ajax and Whitby. The Oshawa plant is usually operated at its capacity and the Ajax and Whitby plants are operated when additional water is required. Due to recent population growth, the Ajax plant is now operated almost continually. The use of the Whitby plant is also increasing as the Region's population increases.

The maximum filter rates are individually set at each filter in the Old Plant, and are remotely set in the control room for each filter in the New Plant. As the clearwell in the New Plant approaches a full condition, the clearwell level override system causes the filter rates to decrease. The Old Plant has a high clearwell level alarm to alert the operators to manually decrease the filtration rate.

(c) Flow Control (cont'd)

HIGH LIFT PUMPING

The Oshawa, Whitby, and Ajax plants provide water to a common distribution system, with Oshawa providing the base load. The number of high lift pumps operating at the Oshawa plant is dependent upon the operation of the other two plants. The three plants maintain a system pressure of 725 - 825 kPa.

(d) Filter Backwashing

The criteria to initiate a filter backwash is time, headloss, or turbidity. The Old Plant filters are normally washed on time, at the end of a 24-hour run. The New Plant filters are usually washed on headloss, when it reaches 1.8 m. If any filter effluent turbidities reach approximately 0.5 NTU, the filter will be backwashed. A copy of the backwashing procedure for the filters in the New Plant is included in Appendix B. The filters in the Old Plant are washed at a rate of 700 m^3/h (28.2 m/h) until the filter is clean (approximately 10-12 minutes).

Each of the six filters in the New Plant is monitored by a turbidity station using a Hach 1720B. The six sample lines from the filter effluents run continuously, and the turbidity station automatically rotates between the filters in operation. Each filter effluent is monitored in sequence for three minutes. A Hach turbidimeter is also available for continuous monitoring the backwash water. However, the staff have not been able to obtain reliable readings from the meter and it is not being used.

As mentioned earlier, the Old Plant filters are backwashed at only one rate. The wash rate of 28.2 m/h provides a bed expansion of approximately 12% at 15°C. The New Plant low and high wash rates of 9.3 and 23.5 m/h provide a bed expansion of approximately 0% and 7%, respectively, at 15°C. Gore & Storrie's experience indicates that the high wash rate should provide a bed expansion of approximately 10% to 35%.

The volume of water used during a backwash is 4.6 to 5.6 m^3/m^2 for the Old Plant, and approximately 3.0 - 3.5 m^3/m^2 for the New Plant. Gore & Storrie's experience indicates that a wash volume of 4.0 to 5.0 m^3/m^2 should properly clean a filter bed, thus, the wash volume used at Oshawa may not be sufficient.

(e) Chemical Dosage Control

There are presently four (4) chemical application points in the Oshawa Water Supply Plant. Pre-chlorine and fluoride are added to the low lift suction well via separate pipes which are located approximately 1 m above the floor level. Alum is added directly into the suction of low lift pump No. 3 or 4. Post-chlorine is added into both of the high lift discharge mains. (Due to a significant build-up of alum in the pumps, the alum application point was changed in December 1987 and is now added with the fluoride and pre-chlorine via a separate pipe into the low lift suction well.)

PRE-CHLORINE

The pre-chlorine dosage is manually adjusted to obtain a free chlorine residual of 0.8 to 1.0 mg/L on the low lift discharge or approximately 0.6 to 0.7 mg/L on top of the filters. The pre-chlorine dosage is flow paced on the raw water flow signal.

There is a continuous chlorine analyzer on the low lift discharge header. The operators conduct free chlorine analyses on grab samples taken every two hours from the low lift discharge and the filter influent. The free chlorine residuals are measured by an amperometric method.

Pre and post chlorine feeds are taken from the same active cylinder. There is no chlorine cylinder scale, and therefore, chlorine dosages cannot be confirmed by weight measurements.

FLUORIDE

Fluoride is added to the water in the form of hydrofluosilicic acid. The acid is fed by a diaphragm metering pump which is flow paced on the raw water flow signal. The stroke is manually adjusted for dosage control.

The fluoride dosage is adjusted to maintain a plant effluent residual of approximately 1.2 mg/L. The acid usage is checked daily measuring the level drop in the 24,500 L storage tank.

FLUORIDE (cont'd)

The fluoride concentration in the treated water is measured three times a day with a Hach DR100 Colourimeter (SPADNS method).

ALUM

During the period examined, the alum dosage varied from 0.1 to 105 mg/L, with a yearly average of 7-8 mg/L.

Raw water quality changes are gradual and relatively small; therefore, the corresponding alum dosage adjustments are also small. In the past, only raw and treated turbidities were measured and recorded. In the last few months, the settled water turbidity has been routinely measured and recorded. The settled water turbidimeter and filter effluent turbidimeter station continuously monitors the respective turbidity values. By measuring a turbidity profile through the plant, a change in raw water turbidity and a corresponding change in settled water turbidity can be recognized and dealt with by a change in alum dosage before significant effects are felt by the filters.

Jar tests are carried out regularly by the operators at the Oshawa Plant. If unusual treatment conditions are encountered, a jar test is performed to assess chemical dosages.

The alum metering pump stroke adjustment for dosage is presently manually set, and the pump speed is flow paced. Daily alum usage is determined by an electronic measurement of the level drop in the 59,000 L bulk storage tank. The daily average alum dosages tabulated in Appendix A were calculated by dividing the 24-hour alum usage by the raw water flow. The 24-hour level drop ranges from 30 to 60 mm per day, depending on the dosage and plant flow rate. The accuracy of the level measurement is better than 1% of the span, however, due to the size of the tank, the precision is ± 30 mm. With such small 24-hour level changes, some inaccuracies in determining the daily alum usage may occur. The Ontario Ministry of the Environment recommends that a more accurate method of determining alum dosage be implemented, such as the use of an alum day tank.

(e) Chemical Dosage Control (cont'd)

POST-CHLORINE

The treated water free chlorine residual is maintained at approximately 0.5 to 0.6 mg/L. The post-chlorine dosage is controlled by a compound loop system.

As mentioned earlier, the pre and post chlorine feeds are taken from the same active cylinder. There is no chlorine scale, and therefore, the chlorine dosage cannot be confirmed by weight measurements.

There is a continuous chlorine analyzer on the high lift discharge. The operators conduct free chlorine analyses on plant effluent grab samples taken every two hours. The free chlorine residuals are measured by an amperometric titration.

(f) Quality Control Testing

The following table lists pertinent information on the sample systems in use at the Oshawa plant:

SOURCE	LENGTH/ SIZE (m/mm)	FLOW (L/min)	VELOCITY (m/s)	TRAVEL TIME (min)
		Max. = Norm.	Max. = Norm.	Max. = Norm.
Raw (intake well)	15/12.7	1.4	0.18	1.4
Chlorinated Raw (between L.L. and mixing tanks)	25/12.7	2.9	0.38	1.1
Treated (discharge line)	60/12.7	5.3	0.70	1.4

NOTE: The sample lines are 12.7 mm PVC.

The sample flow rate was determined by a time-displacement test carried out at the maximum flow rate in use, which is the normal setting. The raw water sampling line velocity is somewhat low; the flowrate through the line should be increased.

There is also a stainless steel DWSP raw water sample line at the old intake well. The total length of the line is approximately 5 m. The suction is 12.7 mm diameter and the discharge is 9.4 mm diameter. DWSP treated water samples are collected from a service line in the laboratory.

(f) Quality Control Testing (cont'd)

IN-PLANT MONITORING

The following table gives a list of the tests performed at the plant:

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT	TEST LOCATION
Cl_2 Residual					
- Pre-free	Low Lift Discharge	1/2 hours	1/2 hours	W&T Amp. Titrator	Lab
- Pre-free	Low Lift Discharge	Continuous	Continuous	W&T Cl_2 Residual Analyzer	On Line
- Pre-free	Top of Filters	1/2 hours	1/2 hours	W&T Amp. Titrator	Lab
- Post-free	High Lift Discharge	1/2 hours	1/2 hours	W&T Amp. Titrator	Lab
- Post-free	High Lift Discharge (electric)	Continuous	Continuous	W&T Cl_2 Residual Analyzer	On Line
Turbidity	Raw (Intake Well)	1/2 hours	1/2 hours	Hach Ratio Turbidimeter	Lab
	Raw (old intake well)	Continuous	Continuous	Hach Surface Scatter Turbidimeter	On Line
	Settled Water Conduit (New Plant)	Continuous	Continuous	Hach Surface Scatter Turbidimeter	Lab
	New Plant Filter 1-6 Effluents	Continuous	Continuous	Hach 1720B Titrator	On Line
	Backwash Water Drain Conduit	Continuous	Continuous	Hach Model 19800 (immersion type turbidimeters)*	On Line

* Can be used to terminate backwash of New Plant filters, see Appendix B.

(f) Quality Control Testing (cont'd)

IN-PLANT MONITORING

TEST	SAMPLE POINT	TESTING FREQUENCY	REPORTING FREQUENCY	TESTING INSTRUMENT	TEST LOCATION
Turbidity	Treated Water (High Lift Discharge)	1/2 hours	1/2 hours	Hach Ratio Turbidimeter	Lab
	Treated Water (High Lift Discharge)	Continuous	Continuous	Hach 1720B	On Line
Temperature	Raw Water (Intake Well)	1/2 hours	Daily	Thermometer	Lab
	Treated (Low Lift Discharge)	Continuous	Continuous	In-Line Probe	On Line
	Treated (High Lift Discharge)	Continuous	Continuous	In-Line Probe	On Line
pH	Raw	Continuous	Continuous	pHOX 45 series pH Meter	On Line
	Raw Discharge	1/day	1/day	Orion Research Model 407A pH meter	On Line
Fluoride	Treated (High Lift Discharge)	1/8 hours	1/8 hours	Hach DR100 Colourimeter	Lab
	Treated (High Lift Discharge)	Continuous	Continuous	W&T F^- Residual Analyzer	On Line

D.2 Operation and Process Concerns

(a) Flocculation Mixing

The type of mixing provided at the plant is dependent on the flow rate to control the level of mixing. The present operating policy is not to isolate sections of the flocculation tanks to maintain higher flow rates through the remaining sections. The details of this condition are discussed later in Section E.

(b) Filters

The six filters in the New Plant are all the same size, however, due to hydraulic restrictions in the filter effluent piping and inlet sluice gates, the filters have different hydraulic capacities. This situation is currently being studied, and recommendations are eminent.

To obtain the maximum hydraulic flow rate through each filter, the filter rates must be manually adjusted to obtain the required water level in each filter. When the filters are being operated at their maximum rates, the flowrate may be dictated by headloss and not remain constant throughout the entire filter run.

(c) Filter Backwashing

In the New Plant, the low and high backwash rates of 9.3 and 23.5 m/h provide a bed expansion of approximately 0% and 7%, respectively, at 15°C. Our experience indicates that the high wash rate should provide a bed expansion of approximately 10% to 35%. The backwash procedure should be reviewed, in particular, the high wash rate, to ensure that the filters are being properly cleaned.

(d) Plant Effluent Turbidity

As shown in Appendix A, Table 6.0, the plant effluent turbidity did exceed the Ontario Drinking Water Maximum Acceptable Concentration of 1 NTU on at least one occasion during the three year study period. Although the treated water turbidity seldom exceeds 1 NTU, conditions which may lead to increased turbidities should be reviewed.

(e) Aluminum Residual

The aluminum residual in the treated water has occasionally exceeded the objective limit of 0.1 mg/L. The topic of aluminum solubility and residual is discussed in detail in the following section.

SECTION E

PLANT PERFORMANCE (PARTICULATE REMOVAL)

SECTION E
PLANT PERFORMANCE (PARTICULATE REMOVAL)

E.1 Turbidity Removal

(a) General

The Oshawa plant must deal with raw water quality conditions as shown:

Turbidity (NTU)	0.24 - 75
Colour (HCU)	2.5 - 7.5
Iron (mg/L)	<0.05 - 0.29
Manganese (mg/L)	0.001 - 0.003
pH	6.8 - 8.4

The raw water quality is generally quite good, however, the turbidity can occasionally exceed 50 NTU. Higher turbidities are usually experienced during the winter/spring period, i.e. November - April. The table below shows the range of turbidity conditions for the two raw water quality periods.

1985 - 1987	RAW WATER TURBIDITY (NTU)		
	Max.	Min.	Avg.
Winter/Spring (Nov. - Apr.)	75	0.6	5.2
Summer/Fall (May - Oct.)	27	0.24	1.4

The raw water turbidities experienced by the plant over the past several years are summarized in the table on the following page. The tabulated turbidity values were taken from grab samples measurements which were recorded every two hours. A graph included in Appendix C as Figure 1.0 shows a Composite Profile of Raw Water Turbidity Ranges for the 1985-1987 period, based on daily average turbidities.

(a) General (cont'd)

1985 - 1987	RAW TURBIDITY (NTU)		
	Max.	Min.	Avg.
January	15	0.77	4.2
February	27	0.60	2.9
March	34	1.10	6.0
April	75	1.00	6.9
May	8.5	0.54	1.2
June	3	0.48	1.1
July	4.1	0.50	1.1
August	27	0.50	1.8
September	12	0.67	1.4
October	18	0.24	1.9
November	20	0.70	3.7
December	26	1.50	7.4

(b) Plant Performance

It is usual to consider two conditions for plant operation, the maximum hydraulic flow rate and the maximum process flow rate. The maximum process condition, from the standpoint of particulate removal, occurs with the highest solids loading on the plant. The maximum flow and worst raw water quality are not coincident at this plant. The flow in any year varies less than about 2:1, while the turbidity and corresponding solids generated within the process can vary about 100:1; therefore, the maximum process condition corresponds to the worst water quality condition.

The plant records for the treated water during the 1985 - 1987 period are summarized on the following page. The tabulated turbidity values were taken from grab sample measurements which were recorded every two hours.

1985 - 1987	TREATED TURBIDITY (NTU)		
	Max.	Min.	Avg.
January	0.40	0.07	0.22
February	0.29	0.08	0.18
March	1.01	0.14	0.22
April	1.30	0.06	0.22
May	0.64	0.06	0.20
June	0.55	0.08	0.18
July	0.55	0.10	0.22
August	0.57	0.07	0.20
September	0.33	0.08	0.16
October	0.40	0.07	0.14
November	0.29	0.05	0.16
December	0.82	0.09	0.18

This table shows that the plant has produced high quality water, with turbidity values well below the objective of 1.0 NTU. A graph included in Appendix C as Figure 1.1 shows a Composite Performance Profile of Treated Water Turbidity Ranges for the period 1985-1987, based on daily average turbidities.

As mentioned earlier, the reported maximum values are the results of bi-hourly sampling conducted by the plant operator; not daily average values. The daily average treated water turbidity did not exceed 1.0 NTU during the period examined. There were only three occasions when a bi-hourly treated water sample exceeded or possibly exceeded 1.0 NTU, as summarized below:

DATE	MAX. DURING DAY (NTU)	AVG. FOR DAY (NTU)
8 April 1985	1.01*	0.59
9 April 1985	1.30	0.46
1 March 1985	1.01*	0.61

* 1.01 NTU may or may not be an exceedence since the difference of 0.01 NTU is not within the precision of the instrument.

It should be noted that the few times the treated water turbidity increased occurred in March and April when the raw water turbidities were elevated.

ASSESSMENT OF OVERALL PERFORMANCE

The turbidity guideline in the Province of Ontario is 1.0 NTU; but clearly it is important to reduce the turbidity to as low a level as practical.

The historic records of the plant have been reviewed as a means to assess plant performance under various operating conditions.

The plant records show that the maximum treated water turbidity (bi-hourly grab samples) was less than the objective turbidity limit of 1.0 NTU during the period examined except for the occasions noted above. The Oshawa Water Supply Plant has achieved very good treated water quality, as the average turbidity values were consistently less than 0.3 NTU, as shown on the previous page. Graphs included in Appendix C as Figures 2.0 to 4.0 show raw and treated turbidities, and the alum dosage for various months during the period examined.

It appears that the time lag involved in making alum dosage adjustments to meet changing raw water conditions may have resulted in the increased treated water turbidities during high raw water turbidity. From the jar tests conducted by Gore & Storrie, it appears that filter effluent turbidities of <0.2 NTU could be achieved with an alum dosage of 3-5 mg/L when raw water turbidity is in the range of 2-3 NTU.

In general, the operation of the Oshawa plant with respect to turbidity removal is very good. Oshawa believes that maintaining the filter effluent below the operating parameter of 0.5 NTU contributes to the good treated water quality.

E.2 Treatability Testing

(a) Jar Testing

TURBIDITY REMOVAL

Treatability testing was carried out on two raw water samples collected on 22 October 1987 and 24 November 1987. The raw water samples had turbidities of 0.60 and 3.1 NTU, respectively. The laboratory and treatability results sheets are included in Appendix D.

Alum was used in coagulation/flocculation/sedimentation testing, followed by filtration through a 1.2 µm membrane filter, which, in Gore & Storrie's experience, emulates the performance of a dual media filter. The results of the testing demonstrate that filtration down to a turbidity of 0.2 NTU or less is achievable with the appropriate alum dosage. Tests were also conducted with alum and several polymers. Similar effluent turbidities of <0.2 NTU were achieved with alum and polymer.

It is Gore & Storrie's opinion that additional testing be carried out by the plant staff to ascertain the relative merits of specific polyelectrolytes to reduce the filter effluent turbidities. This testing should be conducted during an elevated raw water turbidity period.

ALUMINUM RESIDUAL

The use of aluminum salt coagulants (alum, polyaluminum chloride, etc.) in potable water treatment plants may lead to increased aluminum concentrations in treated water, which may result in water quality and supply problems.

There is no evidence that aluminum is physiologically harmful, and no health-related limit has specified anywhere in the world to Gore & Storrie's knowledge. However, the perception of potential health problems associated with aluminum frequently emerges.

Water supply problems may be associated with increased aluminum concentrations in treated water. These problems include the formation of a hydrous aluminum precipitate in the distribution system which may increase turbidity and complaints about clarity. Aluminum floc in the system may interfere with the disinfection process by entrapping and protecting microorganisms. Another problem attributed to increased aluminum concentrations is deposition of aluminum hydrolysis products on pipe walls, which decreases carrying capacity. To minimize these problems, the Ontario Drinking Water Objectives (ODWO) suggest an operational guideline of <0.1 mg/L as Al in the treated water leaving the plant.

An EPA survey of 186 utilities showed that a number of plants exhibited high residual aluminum when overdosing of alum occurred. Even though some utilities surveyed stated that minimizing the alum dosage is a strategy for controlling residual aluminum, underdosing of alum appears to be just as detrimental to turbidity removal and residual aluminum control as overdosing.

Water quality problems associated with high concentrations of aluminum in finished water have led to discussion of ways to reduce residual aluminum concentrations. One method of reducing aluminum concentration is to optimize coagulation. To have optimum coagulation requires that the best coagulant, dosage, and combination of operating conditions be selected for each raw water. The optimum pH range must also be achieved since aluminum is least soluble in water in the pH range 5.5-7.0.

There are treatment plants in Ontario which are currently using residual aluminum as an "operational tool" to optimize the dosage of alum. Operational staff respond to any elevation in residual aluminum and make the necessary adjustments to the plant operation.

Aluminum solubility in water is a complex topic; but some of the most significant variables are pH, time and temperature. For pH values greater than 6.5, the aluminum residual increases directly with pH. Aluminum residual is inversely proportional to time, up to several hours, whereupon the solubility concentration remains fairly constant. The aluminum residual is directly related to temperature, but this has a fairly minor impact over the ranges encountered in natural waters. For times greater than an hour and pH's greater than about 7.4, water may contain a residual concentration greater than 0.1 mg/L.

For the aluminum residuals and pH values found in the waters at the plant, the results are consistent with general experimentally determined values. Therefore, it is not surprising to find aluminum concentrations greater than 0.1 mg/L.

The Oshawa treated water aluminum residuals have occasionally been above the guideline of 0.1 mg/L, therefore, jar tests were run to check the aluminum residual. In Gore & Storrie's opinion, the benefits associated with changing the alum dosage to control the aluminum residual, over and above those for turbidity control, is not warranted.

A minimum of daily monitoring of aluminum residual and pH leaving the plant is recommended by the Ontario Ministry of the Environment. An acceptable method of aluminum analysis should be used. Frequent examination of this data and Drinking Water Surveillance Program (DWSP) data will supply the needed information on the chemistry and fate of aluminum following water treatment to help operating authorities minimize the concentration of aluminum in the treated water.

COAGULANT(S) DOSAGE

From the test work conducted, Gore & Storrie believes that the optimum filter effluent quality is achieved with an alum dosage of about 3-5 mg/L for the raw water conditions experienced during the tests.

(b) Streaming Current Monitor

As mentioned earlier, during periods of changing raw water turbidity, the alum dosage changes may have lagged changes in turbidity. A streaming current monitor (SCM) may allow both a faster response and the selection of the correct coagulant dosages.

E.3 Optimum Removal Strategies

(a) Flash Mixing and Coagulant Addition

The Oshawa plant has one alum application point and no rapid or flash mixing. The raw water flow is discharged into one 762 mm pipe. This pipe feeds the separate Old and New Plant raw water headers.

In order to allow optimum coagulant addition to the Old and New Plants, it is recommended that an investigation be conducted to assess the merit of in-line blenders, alum application points and associated metering pumps and Streaming Current Monitors for each of the two headers. The in-line blenders may be equipped with feed points for alum and a coagulant aid.

(b) Flocculation and Sedimentation

As noted in previous sections, all the flocculation and sedimentation tanks are used at most times. Since the level of mixing in the flocculation tanks is dictated by the flow rate, there may be some marginal benefits obtained from isolating the pre-treatment sections of the plant. The resident time afforded by having all tanks operational is increased at lower flows; thus the mixing system tends to compensate for the reduced flow rates. In addition, the settling tank performance is inversely dependent on the flow rate; therefore, this unit operation tends to also compensate for reduced mixing levels at lower rates by becoming more efficient. However, there are bounds to how low the flow can be before overall performance is affected.

(b) Flocculation and Sedimentation (cont'd)

It is Gore & Storrie's opinion that there is merit to investigating, on a plant scale, the magnitude of improvement which would result from maintaining high flows in the flocculation tanks. From an operational standpoint, however, the performance improvements may only be small and not worth the efforts of opening and closing valves to suit the changing flows. Therefore, the most benefit may arise from a better understanding of the plant unit operations.

(c) Filter Turbidity Monitoring

The filters in the Old Plant do not have individual turbidimeters to monitor each filter's performance.

Each filter effluent should be monitored by a turbidity monitoring station.

(d) Turbidity Profile

One of the most useful sets of information to control and optimize the operation of a water treatment plant is a Turbidity Profile through the plant. The location for these turbidity readings is Raw, Settled and Filter Effluent for each of the Plants.

It is recommended that the collection of this information be maintained separately for the Old and New Plants. These two sets of data allow a comparison between the performance of the two Plants.

(e) Fluoride and Alum Addition

Fluoride and alum are both added to the raw water at the low lift suction well. It is possible that alum may consume some of the fluoride applied. This could explain the high fluoride usage at the plant.

The appropriateness of adding these chemicals together should be investigated.

SECTION F

PLANT PERFORMANCE (DISINFECTION)

SECTION F
PLANT PERFORMANCE (DISINFECTION)

F.1 Disinfection

At the Oshawa Water Treatment Plant, disinfection is carried out by adding chlorine to the raw water in the low lift suction well to achieve a free residual of approximately 0.6 - 0.7 mg/L on top of the filters.

Post chlorine is added to both high lift discharge headers. The post chlorine dosage is controlled by a compound loop system to maintain a free chlorine residual of 0.5 - 0.6 mg/L in the plant effluent.

During the period examined, Presence/Absence tests were conducted on the treated water one to four times a month.

F.2 Disinfection Efficiency

The MOE "Ontario Drinking Water Objectives, 1983" states:

> "Treatment Plant Samples
> In systems utilizing surface water or treated ground water, samples shall be taken from the raw water source and point at which the treated water enters the distribution system, at least weekly in systems serving populations up to 100,000 and more often in larger systems."

The Ontario Drinking Water Objectives (ODWO) criteria for microbiological quality of distributed water quality can be summarized as follows for Total Coliforms (TC), Fecal Coliforms (FC) and Fecal Streptococcus.

1. Unsafe Water Quality

   a) TC bacteria; when determined by the membrane filtration (MF) or most probable number (MPN) method should not be present in densities of 5 or more organisms per 100 mL. When determined by the Presence/Absence (P/A) procedure, the water should not give positive results within 48 hours.

b) FC bacteria; should not be detected in any sample by any of the methods.

2. Poor Water Quality

a) TC bacteria; when present at levels below 5 organisms per 100 mL by MF or MPN tests, they should not occur in more than 25% of samples from a single submission, nor in successive submissions from the same sampling site and not in more than 10% of all samples per month.

b) Fecal Streptococcus bacteria; should not be detected in any sample.

Tables 6.0 to 6.3 in the appendices summarize the available raw and treated water microbiological data for the Oshawa plant.

In February and April 1985, the treated water bacteriological tests were present for coliforms, but fecal coliforms were absent. More frequent bacteriological testing should be conducted. Other tests conducted during the period examined all gave absent as measured by the Presence/Absence test. The bacteriological test procedure and the procedure for handling positive samples are included in Appendix F.

In Gore & Storrie's opinion, the chlorine feed system and the operational procedures seem adequate to control the measured microbiological parameters. It is recommended that separate methods of weighing pre- and post-chlorine feeds be implemented to enable a direct assessment of the dosages.

F.3 Chlorinated By-Products

TRIHALOMETHANES

Trihalomethanes (THM's) are the most widely occurring chlorinated organics found in drinking water, and they also appear at the highest concentrations. The principal source of THM's in drinking water is the chemical interaction of chlorine added for disinfection, with humic and fulvic substances that occur naturally in the raw water. There is some evidence that THM's are carcinogenic. The Ontario Drinking Water Objectives for total THM's is 350 µg/L.

The data shown in Table F.1 indicate that low levels of trihalomethanes occur in the water plant's treated water. Total THM values were determined from July 1985 to present, and the average total trihalomethane (TTHM) value in the plant effluent was 39 µg/L. This is considerably less than the guideline of 350 µg/L. The highest value measured was 60 µg/L and occurred in September 1985.

TOTAL ORGANIC HALIDES

The terms of reference require consideration be given to the reduction of chlorinated by-products in the treated water. There was no complete set of information on the total concentrations of all organohalogen compounds.

It is Gore & Storrie's opinion that a broader measurement of chlorinated by-products and other organic contaminants should be considered and possibly a surrogate measurement should be utilized. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum of all the organic halogen compounds.

TABLE F.1

Trihalomethane Data for Oshawa WTP

		1985		1986		1987	
		R	T	R	T	R	T
JAN	Chloroform, µg/L		23,23,21		20,19		13,18
FEB	($CHCl_3$)				15,15,15		14,14,14
MAR			24,19,30,24		15,17,16		8,11
APR			25,24,24		17,17,16		18,14,19
MAY			25,24,23		15,15,16		23,17,24
JUN							16,16.5
JUL			22,19,14		15,15,14		20,18,25,10
AUG							28,27,25,23
SEP	(4)		30,18,25		12,13,13		26,25,25,21
OCT			15,14,14				25,23,22
NOV							
DEC			17,20,19				
JAN	Bromodichloromethane, µg/L		15,15,15		13,12		12,20
FEB	($CHBrCl_2$)				12,12,11		14,17,13
MAR			15,15,15,16		13,12,12		
APR			16,15,15		11,11,10		12,12,12
MAY			14,14,14		11,10,11		20,8,18
JUN							
JUL			14,12,10		18,15,8		28,22,26,19
AUG							23,23,22,21
SEP	(4)		23,15,17		7,13,10		19,20,20,17
OCT			12,12,15				20,19,20
NOV							
DEC			12,14,13				
JAN	Chlorodibromomethane, µg/L		7,7,7		6,6		6,1
FEB	($CHBr_2Cl$)				7,7,6		7,8,7
MAR			5,6,6,6		9,7,7		5,5
APR			5,6,5		6,5,5		4,4,4
MAY			6,6,6		6,6,5		9,8
JUN							5.9,6.2
JUL			6,6,5		9,8,6		9,7,8,7
AUG							8,8,8,8
SEP	(4)		7,6,5		3,4,4		7,7,8,7
OCT			6,6,6				8,8,7
NOV							
DEC			5,5,5				
JAN	Bromoform, µg/L						
FEB	($CHBr_3$)						
MAR							
APR							
MAY							
JUN							
JUL							
AUG							
SEP	(4)						
OCT							
NOV							
DEC							

TABLE F.1 (cont'd)

		1985		1986		1987	
		R	T	R	T	R	T
JAN	Total THM's, µg/L		45,45,43		39,37		21,39
FEB					34,34,32		35,39,34
MAR			45,40,51,46		37,36,35		21,25
APR			46,45,44		34,33,31		34,30,35
MAY			45,44,43		32,31,32		52,25,50
JUN							35,35.8
JUL			42,37,29		42,38,28		57,47,59,36
AUG							59,58,55,52
SEP	(4)		60,39,47		22,30,27		52,52,53,45
OCT			33,32,35				53,50,49
NOV							
DEC			34,39,31				
AVG.	Total THM's, µg/L		43		33		42
RNG.	Total THM's, µg/L		21 - 59		22 - 39		31 - 60

R - Raw water
T - Treated water

Data taken from MOE test results

SECTION G

SHORT AND LONG-TERM MODIFICATIONS

SECTION G
SHORT AND LONG-TERM MODIFICATIONS

G.1 Description

This section includes feasible short and long-term process modifications required to approach optimum disinfection and particulate removal. It is important to understand that optimization of selected process steps may be in conflict with other aspects of the plant, such as staffing and budgeting costs. Estimated costs for each recommendation are also included.

The following short and long-term recommendations were provided, discussed, reviewed, and agreed upon at the plant site meeting.

Costs have been assigned for each of the recommended works. These costs may be reduced if Regional operational staff carries out the work.

G.2 Coagulant Application Point

The Region had been attempting better mixing by adding the alum directly into the suction of low lift pumps 3 and 4. This practice was recently discontinued due to the significant build-up of alum occurring in the pump. Alum is now added into the low lift suction well.

It is recommended that separate alum feed systems be installed for each raw water discharge header. Separate metering systems should be provided to allow for separate chemical dosing, and this would require separate flow metering of each header for flow pacing.

The estimated cost for this work is $40,000 to $50,000.

G.3 Fluoride Application

Fluoride and alum are both fed into the low lift suction well. It has been speculated that alum may consume part of the fluoride dosage.

It is recommended that controlled testing be conducted to determine if the present method of adding alum and fluoride together is responsible for any fluoride consumption. If the alum is consuming fluoride, consideration should be given to moving the fluoride injection point.

The testing can be conducted immediately. The cost of the testing would be $5,000 to $10,000.

G.4 Chemical Mixing

There are two mechanisms of mixing chemicals into the main process stream: blending and flash mixing. Blending consists of the distribution of chemicals uniformly throughout the body of the process stream and is characterized by relatively high velocity gradients of greater than 200 sec^{-1} for periods of up to several minutes. Flash mixing addresses the coagulation concept that blending must occur within a very short period of time, a matter of seconds, and this requires very high velocity gradients of greater than 1000 sec^{-1}. It is important to recognize the difference between these two concepts and their process implications. Blending mixing is to ensure that the process components will behave uniformly. Flash mixing has been espoused by some researchers in water chemistry as improving the coagulation process.

There is no flash mixing at the Oshawa plant. The coagulant is added to the raw water in the suction well and uniform distribution throughout the stream is not ensured.

It is recommended that a series of laboratory tests followed by plant tests be conducted to determine the relative merits of blending and/or flash mixing as compared to the present system. Should the tests prove the cost benefit of either form of mixing, consideration should be given to installing appropriate units.

G.4 Chemical Mixing (cont'd)

This work can be carried out at any time. The cost of the study would be approximately $30,000. The cost of two in-line blenders would be approximately $100,000 to buy and install.

G.5 Streaming Current Monitor (SCM)

Accurate and timely adjustments to the coagulant feed rates are a vital part of achieving optimum particulate removal. The present time lag between the alum feed adjustment and the results at the filter inlet is several hours. The purpose of the SCM is to permit a response to changing raw water conditions in a few minutes.

It is recommended that the Region continue to conduct tests to evaluate the merits of a SCM. If the tests are favourable, a SCM should be purchased and installed.

This work could be conducted at any time. The cost for a SCM is $10,000 to $15,000, depending on the associated equipment.

G.6 Coagulant and Coagulant Aids

Enhanced coagulation/flocculation performance may result from the use of coagulant aids and/or other primary coagulants such as polyaluminum chloride.

It is recommended that the Region continue to carry out laboratory tests to pre-screen the various polyelectrolytes available for use as coagulant aids; including activated silica. Should these tests show that coagulant aids have merit, carry out a plant-scale program for various seasons of the year. The tests should also examine various primary coagulants. These tests should attempt to identify the optimum location/timing for addition of the coagulant and coagulant aid.

The test work could be carried out by plant staff and would result in only marginal costs. The operating costs would increase if a coagulant aid is used.

G.7 Coagulant Dosage

The Oshawa daily alum usage is determined by an electronic measurement of the level drop in the 59,000 L bulk storage tank. The 24-hour level drop ranges from 30 to 60 mm per day, depending on the dosage and plant flow rate. The accuracy of the level measurement is better than 1% of the span, however, due to the size of the tank, the accuracy is ± 30 mm. With such small 24-hour level changes, some inaccuracies in determining the daily alum usage may occur.

The Ontario Ministry of the Environment recommends that a more accurate method of determining alum dosage be implemented, such as the use of a day tank or calibration cylinders on the feed pumps.

G.8 Flow Pattern in Flocculation Tanks

The Old Plant flocculation tanks have top entry into the second tank. Water enters the bottom of the first cell, the top of the second cell, and the bottom of the third or fourth cell. Test work at other facilities has shown improved performance when all cells have bottom entries.

It is recommended that consideration be given to converting the top entry flocculation tanks in the Old Plant to "bottom" entry. This conversion can be done by using corner baffles. The work should be conducted based on the future use of the Old Plant.

This work could be conducted at any time. The cost to retrofit three cells of the Old Plant flocculation tanks is $10,000 to $20,000.

G.9 Filter Cleaning

Experience indicates that a high backwash rate should provide a bed expansion of 10% to 35%. The New Plant high backwash rate of approximately 20 m/h, provides a bed expansion of approximately 5% at 15°C.

G.9 Filter Cleaning (cont'd)

It is recommended that the backwash procedure be investigated to ensure that the low and high wash rates provide an adequate backwash. The low bed expansion may inhibit the effectiveness of the backwash. The backwash must maintain the long term cleaning of the filters. Gore & Storrie does not believe air scouring is required since an adequate wash can be obtained with the use of the agitators. Hydraulic limitations on the backwash drain system should also be investigated before any changes in the backwash rates are implemented.

The Ministry of the Environment has suggested that Oshawa investigate the merits of "filtering to waste" immediately following a backwash.

This work could be carried out at any time. The recommendation could be conducted by Region of Durham staff.

G.10 Filter Media Characteristics

The characteristics of filter media can change with time. Media can be lost during backwashing and, in some instances, media can escape through support systems and end up in the clearwell. The anthracite media actually breaks up by mechanical abrasion over a period of time.

It is recommended that the distance from the filter walkway to the top of the media for each filter continue to be measured and recorded once every year. This measurement should be carried out at four locations in each filter immediately after placing the filter back on line following a backwash. It is recommended that sieve analysis and grain size characterization tests be conducted on each filter once every five years. These records become an early warning of media problems.

G.11 Filter Effluent Turbidimeters

The use of filter effluent turbidimeters enables monitoring of individual filter effluent quality. An increased filter effluent turbidity can be detected and the filter backwashed before any significant increase in plant effluent is observed.

G.11 Filter Effluent Turbidimeters (cont'd)

It is recommended that either individual filter effluent turbidimeters or turbidity monitoring stations be installed to monitor the effluents of the Old Plant filters.

This work should be conducted as soon as possible. The total cost of eight individual effluent turbidimeters would be approximately $25,000 to $30,000.

G.12 Turbidity Profile

It is believed that a Turbidity Profile through the plant is a useful operating tool which provides a good set of data for the purpose of plant performance review.

It is recommended that a turbidity profile, consisting of raw, settled, and filtered turbidities, be recorded for each of the plants. The profile should be recorded on a minimum of once every four hours.

This recommendation has been implemented.

G.13 Chlorine Dosage and Verification

There are no chlorine weigh scales at the Oshawa plant. Pre- and post-chlorine are presently fed from the same cylinder.

It is recommended that two weigh scales be installed to allow individual weighing of pre- and post-chlorine feeds. Feed pre- and post-chlorine from two separate cylinders.

This work could be conducted at any time. The cost would be approximately $5,000 to $10,000.

G.14 Roof Drains

The roof drains on the Old Plant drain into the top of the filters. The Ontario Ministry of the Environment recommends that the piping be changed so that roof drains do not empty into the filters.

G.14 Roof Drains (cont'd)

This work could be conducted at any time. The cost for piping modifications would be approximately $5,000.

G.15 Record of Information

It is recommended that the Plant's record of information include a process and piping diagram (PAPD). As new facilities come on line, or as present facilities are deleted, the PAPD should be modified. Modifications to the PAPD are easily made if the diagram is on a CAD (computer aided drafting) system.

G.16 Chlorinated By-Products

It is Gore & Storrie's opinion that a broader measurement of chlorinated by-products and other organic contaminants should be considered. Although there is not general agreement in the field which surrogate measurement should be used, the measurement should report the sum of all the organic halogen compounds.

It is recommended that the Province of Ontario develop a surrogate for chlorinated by-products and other organic contaminants.

APPENDIX A
TABLES

TABLE 1.0: FLOWS (ML/d)

MONTH	R/T	1987			1986			1985		
		MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	R	N/A	N/A	N/A	97.40	71.84	91.40	102.89	79.54	93.09
	T	91.65	68.10	85.45	94.77	79.47	88.15	90.95	69.56	81.98
FEB	R	N/A	N/A	N/A	N/A	N/A	N/A	102.03	84.31	93.65
	T	94.53	73.90	83.89	91.42	N/A	88.11	90.72	72.71	83.32
MAR	R	101.94	79.10	90.83	N/A	N/A	N/A	104.90	83.96	93.26
	T	90.97	53.31	82.20	95.55	79.78	88.72	92.25	72.06	84.59
APR	R	101.57	75.80	92.23	112.79	89.16	101.19	106.81	76.32	96.18
	T	94.97	69.52	82.30	98.34	78.58	90.80	93.94	68.13	84.75
MAY	R	116.19	64.51	94.03	107.16	64.69	96.89	106.44	77.18	97.85
	T	(95.59)	71.27	86.41	(103.53)	70.63	89.95	(104.42)	65.21	88.01
JUN	R	103.51	49.81	88.46	109.65	65.36	96.62	105.69	58.63	87.87
	T	89.98	47.06	78.42	94.41	57.84	87.09	98.58	54.24	81.42
JUL	R	97.78	58.61	82.90	105.49	77.94	97.58	105.74	53.75	91.29
	T	90.41	N/A	77.82	97.62	71.77	90.68	95.72	57.11	81.96
AUG	R	103.72	69.18	87.55	99.73	74.94	87.22	109.28	66.77	92.00
	T	89.64	64.50	80.41	93.89	62.29	81.23	100.3	61.77	85.57
SEP	R	95.47	71.91	85.37	104.67	75.11	92.36	99.34	70.05	86.84
	T	84.76	67.41	77.57	96.57	70.43	86.94	94.91	60.89	85.48
OCT	R	100.03	58.78	86.18	101.06	66.14	84.44	102.69	74.21	88.55
	T	88.95	54.99	78.84	91.04	60.89	78.41	98.22	71.67	84.81
NOV	R				99.12	73.03	89.49	100.01	N/A	87.79
	T				88.23	73.19	82.05	91.31	78.10	86.04
DEC	R				108.32	76.34	91.71	96.85	65.53	86.06
	T				97.33	67.25	82.64	91.47	63.68	86.05

NOTE: Data obtained from computer printouts of plant pumpages and Oshawa Water Supply Plant Flow Sheets.
Brackets indicate maximum day for the year.

R = Raw; T = Treated
N/A = Data not available - Raw water pumpage not recorded

TABLE 2.0: PARTICULATE REMOVAL SUMMARY

MONTH	PARAMETER			1987			1986			1985		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JAN	Turbidity (NTU)		R	15.0	1.20	4.20	15.0	1.60	4.60	10.5	0.77	3.68
			T	0.35	0.10	0.17	0.30	0.07	0.14	0.40	0.11	0.21
	Colour (TCU)		R									7.5
			T									1.0
	Alum	(mg/L)		8.5	2.9	5.3	24.4	4.2	11.7	12.99	1.0	5.4
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T			0.290			0.100			0.073
	pH		R	8.1	7.5	7.9						8.12
			T									7.66
	Temperature	(°C)		4	0.5	2.5	3.2	0	1.5	2.5	1	1.6
FEB	Turbidity (NTU)		R	14.0	1.0	2.50	9.20	0.75	2.90	27	0.60	3.44
			T	0.29	0.09	0.17	0.30	0.08	0.14	0.52	0.10	0.22
	Colour (TCU)		R									
			T									
	Alum	(mg/L)		12.2	3.8	5.2	26.6	4.5	13.2	16.2	3.3	6.8
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T	0.09	0.045	0.062			0.052			
	pH		R	8.1	7.85	8.0						
			T									
	Temperature	(°C)		4.5	0.5	2.3	2	0	1.1	2.5	0.5	1.3

NOTE: Turbidity data obtained from Daily Log Sheets. Max. and min. turbidity are absolute values from bi-hourly readings. Monthly averages are calculated from the daily averages. Alum dosage obtained from Daily Log Sheet (alum usage divided by raw water pumpage equals dosage). Raw pH readings taken daily, started October 1986. Other reported raw and treated average pH values taken from DWSP - single sample taken monthly. Colour and Al residuals for May to August 1987 taken from DWSP, all others taken from MOE sampling sheets.

R = Raw T = Treated

TABLE 2.0 (cont'd.)

MONTH	PARAMETER			1987			1986			1985		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
MAR	Turbidity (NTU)		R	22.0	1.8	4.1	28.0	1.10	4.70	34	1.6	9.23
			T	0.88	0.15	0.20	0.48	0.04	0.17	1.01	0.14	0.29
	Colour (TCU)		R									
			T									
	Alum	(mg/L)		12.4	3.8	7.7	N/A	N/A	N/A	23.5	3.8	8.3
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T	0.830	0.064	0.225			0.072			0.220
	pH		R	8.4	7.6	8.2						
			T			8.01						
	Temperature	(°C)		6	1.5	3.1	4	0.6	1.9	3.5	1	2.3
APR	Turbidity (NTU)		R	26.0	1.25	6.1	8.0	1.0	2.8	75	1.2	11.79
			T	0.42	0.10	0.19	0.95	0.06	0.16	1.30	0.19	0.32
	Colour (TCU)		R									
			T									
	Alum	(mg/L)		13.2	3.6	7.0	19.7	3.76	9.4	19.4	3.9	10.3
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T	0.150	0.093	0.126			0.110			0.081
	pH		R	8.3	7.7	8.2						
			T									
	Temperature	(°C)		8	2	5.9	7	2	5.0	7	2.5	4.5

NOTE: Turbidity data obtained from Daily Log Sheets. Max. and min. turbidity are absolute values from bi-hourly readings. Monthly averages are calculated from the daily averages. Alum dossge obtained from Daily Log Sheet (alum usage divided by raw water pumpage equals dosage). Raw pH readings taken daily, started October 1986. Other reported raw and treated average pH values taken from DWSP - single sample taken monthly. Colour and Al residuals for May to August 1987 taken from DWSP, all others taken from MOE sampling sheets.

N/A = Data unavailable - Raw water pumpage not available to calculate alum dosage.

TABLE 2.0 (cont'd.)

MONTH	PARAMETER			1987			1986			1985		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
MAY	Turbidity (NTU)		R	8.5	0.9	1.5	2.0	0.57	0.88	2.6	0.54	1.18
			T	0.63	0.09	0.18	0.38	0.06	0.12	0.64	0.14	0.31
	Colour (TCU)		R									2.5
			T									<.5
	Alum	(mg/L)		13.4	3.0	6.2	15.6	0.09	7.9	15.9	3.7	7.0
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R			0.021						
			T			0.086			0.070			0.187
	pH		R	8.15	7.3	7.9						8.20
			T			8.04						7.67
	Temperature	(^oC)		12	6.5	8.5	9.5	4	6.5	9	5	7.3
JUN	Turbidity (NTU)		R	2.5	0.5	1.2	2.0	0.48	0.77	3.0	0.68	1.25
			T	0.49	0.12	0.20	0.22	0.08	0.13	0.55	0.12	0.22
	Colour (TCU)		R									
			T									
	Alum	(mg/L)		11.8	3.7	5.5	11.7	3.7	6.9	13.8	3.5	7.7
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R			<0.004						
			T			0.045						
	pH		R	7.9	6.9	7.6						
			T			7.94						
	Temperature	(^oC)		15.5	7.5	10.9	16	6	8.4	9	5	6.8

NOTE: Turbidity data obtained from Daily Log Sheets. Max. and min. turbidity are absolute values from bi-hourly readings. Monthly averages are calculated from the daily averages. Alum dossge obtained from Daily Log Sheet (alum usage divided by raw water pumpage equals dosage). Raw pH readings taken daily, started October 1986. Other reported raw and treated average pH values taken from DWSP - single sample taken monthly. Colour and Al residuals for May to August 1987 taken from DWSP, all others taken from MOE sampling sheets.

R = Raw T = Treated

TABLE 2.0 (cont'd.)

MONTH	PARAMETER		1987			1986			1985		
			MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
JUL	Turbidity (NTU)	R	3.5	0.89	1.3	1.6	0.50	0.79	4.1	0.77	1.29
		T	0.40	0.10	0.22	0.30	0.10	0.15	0.55	0.16	0.29
	Colour (TCU)	R									
		T									
	Alum (mg/L)		13.9	4.0	6.2	8.7	0.90	5.6	14.4	4.6	9.4
	Coagulant Aid (mg/L)										
	(1) (mg/L)										
	(2) (mg/L)										
	(3) (mg/L)										
	(4) (mg/L)										
	Metal Res. Al (mg/L)	R			0.036						
		T			0.120			0.100			0.085
	pH	R	8.15	6.9	7.8						
		T			7.99						
	Temperature (^{o}C)		17	7.3	12.9	15	5	10.5	9	5	16.8
AUG	Turbidity (NTU)	R	27.0	0.5	2.3	7.6	0.68	1.38	6.4	0.80	1.67
		T	0.38	0.07	0.19	0.57	0.09	0.17	0.44	0.12	0.24
	Colour (TCU)	R									
		T									
	Alum (mg/L)		14.2	3.9	7.8	10	4.1	6.05			
	Coagulant Aid (mg/L)										
	(1) (mg/L)										
	(2) (mg/L)										
	(3) (mg/L)										
	(4) (mg/L)										
	Metal Res. Al (mg/L)	R			0.063						
		T			0.180						
	pH	R	8.15	6.8	7.55						
		T			7.98						
	Temperature (^{o}C)		23	7.5	17	23	3.5	12.1	22	11	17.2

NOTE: Turbidity data obtained from Daily Log Sheets. Max. and min. turbidity are absolute values from bi-hourly readings. Monthly averages are calculated from the daily averages. Alum dossge obtained from Daily Log Sheet (alum usage divided by raw water pumpage equals dosage). Raw pH readings taken daily, started October 1986. Other reported raw and treated average pH values taken from DWSP - single sample taken monthly. Colour and Al residuals for May to August 1987 taken from DWSP, all others taken from MOE sampling sheets.

R = Raw

T = Treated

TABLE 2.0 (cont'd.)

MONTH	PARAMETER			1987			1986			1985		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
SEP	Turbidity (NTU)		R	12.0	0.90	1.31	4.2	0.76	1.37	6.60	0.67	1.39
			T	0.28	0.08	0.13	0.28	0.09	0.14	0.33	0.11	0.20
	Colour (TCU)		R									
			T									
	Alum	(mg/L)		12.4	4.1	7.7	12.6	3.8	7.1	16.3	4.1	8.6
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T			0.133			0.150	0.400	0.200	0.260
	pH	.	R	8.0	7.5	7.7						
			T									
	Temperature	(°C)		21	9	17.4	16	4	11.2	20	11	17.8
OCT	Turbidity (NTU)		R	14.0	0.54	1.67	10	0.24	2.53	18.0	0.40	1.27
			T	0.40	0.05	0.13	0.28	0.08	0.15	0.33	0.07	0.13
	Colour (TCU)		R									
			T									
	Alum	(mg/L)		9.8	3.9	5.5				14.7	3.6	6.8
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T						0.068			0.200
	pH		R	7.6	7.1	7.4	8.1	7.0	7.63			
			T									
	Temperature	(°C)		13.7	5	9.5	17	4	8.5	14.5	7	11.1

NOTE: Turbidity data obtained from Daily Log Sheets. Max. and min. turbidity are absolute values from bi-hourly readings. Monthly averages are calculated from the daily averages. Alum dossge obtained from Daily Log Sheet (alum usage divided by raw water pumpage equals dosage). Raw pH readings taken daily, started October 1986. Other reported raw and treated average pH values taken from DWSP - single sample taken monthly. Colour and Al residuals for May to August 1987 taken from DWSP, all others taken from MOE sampling sheets.

R = Raw T = Treated

TABLE 2.0 (cont'd.)

MONTH	PARAMETER			1987			1986			1985		
				MAX.	MIN.	AVG.	MAX.	MIN.	AVG.	MAX.	MIN.	AVG.
NOV	Turbidity (NTU)		R				20	0.70	3.9	12.0	0.90	3.58
			T				0.29	0.05	0.17	0.28	0.08	0.15
	Colour (TCU)		R									
			T									
	Alum	(mg/L)					9.5	3.9	6.1	31.7	4.8	13.9
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T						0.086			0.300
	pH		R				8.10	7.20	7.77			
			T									
	Temperature	(°C)					10	3	5.9	11.5	4.3	8.3
DEC	Turbidity (NTU)		R				24	1.5	8.6	26.0	2.20	6.14
			T				0.28	0.09	0.18	0.82	0.10	0.18
	Colour (TCU)		R						4.5			
			T						1.5			
	Alum	(mg/L)					17.2	3.8	7.2	104.8	4.4	18.3
	Coagulant Aid	(mg/L)										
	(1)	(mg/L)										
	(2)	(mg/L)										
	(3)	(mg/L)										
	(4)	(mg/L)										
	Metal Res. Al	(mg/L)	R									
			T									0.061
	pH		R				8.10	7.20	7.83			
			T						8.11			
	Temperature	(°C)					6	1	3.1	5	1.1	3.4

NOTE: Turbidity data obtained from Daily Log Sheets. Max. and min. turbidity are absolute values from bi-hourly readings. Monthly averages are calculated from the daily averages. Alum dossge obtained from Daily Log Sheet (alum usage divided by raw water pumpage equals dosage). Raw pH readings taken daily, started October 1986. Other reported raw and treated average pH values taken from DWSP - single sample taken monthly. Colour and Al residuals for May to August 1987 taken from DWSP, all others taken from MOE sampling sheets.

R = Raw T = Treated

TABLE 2.1: PARTICULATE REMOVAL PROFILE (JAN/85)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	8.5			0.23	7.5	1.0	N/A							0.066	8.12	7.66	2
2	6.4			0.23			4.4										2
3	3.4			0.18			7.8										2
4	1.9			0.19			4.2										2.2
5	2.3			0.22			1.0										2.3
6	4.5			0.30			4.2										2.5
7	4.9			0.23			3.9										1.8
8	2.6			0.24			7.7										1.3
9	1.7			0.20			4.2										1
10	1.2			0.21			4.1										1
11	1.0			0.18			4.2										1
12	3.1			0.22			4.1										1
13	3.9			0.23			8.8							0.080			1.7
14	6.0			0.21			7.1										2
15	4.3			0.23			4.1										1.7

TABLE 2.1 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	1.7			0.20			4.2										1.3
17	3.2			0.24			4.0										1.2
18	2.8			0.25			N/A										1.8
19	1.8			0.24			4.5										2
20	4.4			0.25			4.3										2
21	8.0			0.24			7.5										1.3
22	7.3			0.22			13.0										1
23	5.5			0.21			7.9										1.2
24	4.4			0.15			4.6										1.3
25	4.2			0.18			7.7										1
26	1.6			0.19			N/A										1
27	3.8			0.19			4.3										1
28	3.6			0.17			4.1										1.8
29	2.2			0.24			N/A										2
30	1.3			0.17			4.4										2
31	2.5			0.20			4.3										1.8

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.2: PARTICULATE REMOVAL PROFILE (APR/85)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	18.7			0.29			3.9										3
2	13.3			0.28			11.5										2.8
3	20.2			0.36			8.4										2.8
4	17.6			0.33			11.3										3
5	14.7			0.30			8.7										5
6	28.2			0.29			14.3										3
7	34.4			0.32			10.2										3
8	30.3			0.59			19.4										3.7
9	24.7			0.46			15.7							0.081			4.3
10	16.5			0.25			16.1										3.3
11	15.7			0.28			11.8										3
12	11.6			0.33			11.9										3.8
13	12.0			0.32			12.5										3.8
14	12.4			0.30			13.9										3.5
15	11.3			0.33			11.7										3.8

TABLE 2.2 (cont'd)

Page 2 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	8.3			0.32			18.2										4
17	6.1			0.29			N/A										5
18	8.0			0.23			7.6										5
19	6.0			0.32			7.9										6
20	3.8			0.24			7.9										6
21	6.6			0.33			12.1										5.8
22	6.0			0.33			7.6										5.8
23	4.8			0.33			4.1										5
24	3.6			0.34			7.5										5
25	4.3			0.32			7.7										5.8
26	3.6			0.24			7.7										6
27	3.5			0.27			8.1										6
28	2.7			0.27			4.2										5.7
29	3.3			0.30			7.8										5.8
30	1.5			0.28			8.3										5.3
31																	

NOTE: pH and Al residuals obtained from OWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from OWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.3: PARTICULATE REMOVAL PROFILE (JUL/85)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AlO	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.1			0.20			4.9										7
2	1.2			0.24			14.2							0.085			7.3
3	1.1			0.24			12.5										8.3
4	1.4			0.23			7.6										8.5
5	1.2			0.26			7.5										9.5
6	1.6			0.26			8.4										12.3
7	1.2			0.25			6.8										12.3
8	1.2			0.26			14.4										11
9	1.5			0.28			7.6										11
10	1.7			0.34			7.6										11
11	1.1			0.24			11.4										10.5
12	1.2			0.29			11										8.5
13	1.3			0.32			7.6										9.8
14	2.7			0.43			4.6										9.3
15	1.5			0.31			9.7										9.2

TABLE 2.3 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	1.4			0.35			N/A										10.2
17	1.2			0.32			14.3										10.2
18	1.4			0.27			4.9										9.3
19	1.3			0.33			8.2										9
20	1.2			0.33			10.0										10.5
21	1.2			0.32			9.6										11
22	1.1			0.32			8.4										10.3
23	1.2			0.28			9.2										8.3
24	1.1			0.28			8.0										8
25	1.3			0.30			11.0										8.7
26	1.2			0.29			7.7										10
27	1.2			0.29			12.2										10.3
28	1.1			0.25			11.3										11
29	1.1			0.26			11.9										11.7
30	1.0			0.26			11.7										12.8
31	1.0			0.28			9.2										15.7

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.4: PARTICULATE REMOVAL PROFILE (OCT/85)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.0			0.15			4.2										13
2	1.2			0.14			9.3							0.200			10.5
3	0.9			0.15			13.3										8.3
4	1.3			0.17			9.9										9.5
5	7.1			0.16			12.4										14
6	5.8			0.17			4.1										9
7	1.0			0.11			N/A										7.7
8	1.1			0.11			9.4										7.3
9	1.0			0.14			5.0										7.6
10	0.9			0.13			13.5										8
11	0.9			0.12			3.6										8.3
12	1.2			0.12			9.6										9
13	1.1			0.13			14.7										10
14	0.8			0.13			10.5										12
15	0.8			0.14			4.7										11.7

TABLE 2.4 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	0.8			0.13			13.8										13
17	1.6			0.15			12.4										12.3
18	1.5			0.13			4.1										13.3
19	0.9			0.16			12.2										13
20	0.7			0.13			8.6										13
21	0.9			0.13			12										13
22	0.8			0.18			14.7										13.5
23	0.6			0.13			9.3							0.200			13.8
24	0.8			0.13			12.1										14
25	1.0			0.12			8.0										14
26	0.7			0.11			11.9										13.8
27	0.6			0.11			8.3										13.5
28	0.6			0.12			11.3										10
29	0.5			0.12			4.4										9.3
30	0.4			0.10			N/A										11
31	1.0			0.09			14.0										8

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.5: PARTICULATE REMOVAL PROFILE (JAN/86)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Sel.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	6.4			0.17	<.5		9.1							0.100	9.28	7.91	1.8
2	5.6			0.20			17.6										2.3
3	5.2			0.18			16.2										2.0
4	2.9			0.12			4.3										2.3
5	4.9			0.13			14.8										1.8
6	8.7			0.24			8.4										1.3
7	3.7			0.14			8.2										1.0
8	2.6			0.13			12.4										1.5
9	9.3			0.13			24.4										2.0
10	5.8			0.15			N/A										1.5
11	6.7			0.18			8.1										1.5
12	9.5			0.14			16.4										2.0
13	6.6			0.17			12.2										2.7
14	4.7			0.12			4.4										2.0
15	2.4			0.14			N/A										1.8

TABLE 2.5 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	3.1			0.11			8.2										1
17	4.6			0.14			20.6										1.7
18	3.9			0.13			4.2										1.7
19	2.1			0.14			9.0										1.8
20	1.9			0.13			8.4										1.5
21	2.0			0.14			12.0										1.2
22	4.9			0.14			8.2										1
23	3.5			0.13			12.6										1.5
24	2.2			0.11			8.4										1.6
25	8.1			0.13			12.7										1.3
26	3.7			0.13			12.7										0.8
27	2.8			0.11			8.5										1.7
28	3.5			0.15			13.2										0.6
29	5.3			0.16			12.6										1.2
30	3.1			0.14			8.6										1
31	4.3			0.12			21.7										1.2

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

[1] Unreliable sample decomposition noted for raw pH sample.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.6: PARTICULATE REMOVAL PROFILE (APR/86)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	2.7			0.10			N/A										3
2	2.4			0.12			N/A										3.2
3	2.2			0.10			N/A										4.7
4	2.7			0.12			N/A										3.7
5	2.7			0.11			N/A										4
6	5.1			0.12			N/A										4
7	6.0			0.11			N/A										4
8	4.3			0.17			N/A										5
9	3.4			0.12			N/A							0.110			4.2
10	3.6			0.26			N/A										4.7
11	2.6			0.54			N/A										4.2
12	3.9			0.28			19.2										5
13	2.3			0.12			7.7										4.8
14	2.2			0.13			3.8										4.3
15	2.4			0.15			7.3										5.3

TABLE 2.6 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	3.7			0.23			3.8										4.3
17	3.6			0.30			N/A										5
18	3.8			0.37			19.7										5.5
19	3.6			0.11			15.4										5.5
20	3.1			0.10			7.9										6.3
21	3.1			0.13			7.5										5.7
22	2.5			0.10			7.5										6
23	2.1			0.12			11.4										6
24	1.4			0.11			N/A										6
25	1.5			0.11			11.9										5.7
26	1.3			0.10			10.3										6
27	1.2			0.11			4.0										5.4
28	1.5			0.22			N/A										6.7
29	1.3			0.14			N/A										6.6
30	1.0			0.14			3.9										5.6
31																	

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.7: PARTICULATE REMOVAL PROFILE (JUL/86)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	0.7			0.14			4.4										8
2	0.8			0.15			7.7							0.070			7.2
3	0.6			0.13			N/A										7.8
4	0.7			0.12			3.7										6.5
5	0.7			0.11			8.0										7
6	0.7			0.11			7.9										5
7	0.7			0.12			7.5										6
8	0.8			0.13			3.6										6
9	0.7			0.12			7.5										6
10	0.7			0.13			7.6										6.2
11	0.7			0.12			3.8										6.2
12	0.9			0.15			8.2										6
13	0.8			0.14			4.1										7.7
14	0.6			0.15			7.7										11.7
15	0.7			0.14			3.9										10.3

TABLE 2.7 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^oC)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	0.7			0.13			7.4										11
17	0.8			0.18			0.8										12.3
18	0.6			0.16			3.9										14.3
19	0.7			0.15			4.3										14
20	0.7			0.16			0.9										15
21	0.7			0.15			4.2										13.8
22	0.7			0.15			7.7										13.5
23	0.8			0.18			3.8										13
24	1.0			0.19			7.4										14
25	1.0			0.21			7.6										14.5
26	1.0			0.17			3.9										15
27	1.0			0.20			5.0										15
28	1.1			0.23			7.9										15
29	1.3			0.19			4.2							0.130			14.8
30	0.9			0.17			8.7										12.3
31	0.8			0.17			4.2										10

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.8: PARTICULATE REMOVAL PROFILE (OCT/86)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.0			0.12			7.7										15.7
2	1.0			0.10			8.0										14.7
3	2.0			0.12			8.1										13.7
4	2.7			0.16			9.8										14
5	2.7			0.14			11.6										13
6	5.9			0.13			N/A								7.4		9.3
7	1.1			0.11			9.2								7.6		6
8	3.0			0.12			5.2								7.6		5.7
9	1.8			0.11			12.9								7.6		6.2
10	2.8			0.12			4.9								7.6		4.7
11	4.9			0.13			9.5										5.7
12	3.3			0.13			5.5										7
13	2.2			0.13			11.7										7
14	2.6			0.13			13.5								7.5		8.5
15	5.1			0.15			8.4								7.4		8.2

TABLE 2.8 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	3.2			0.15			4.3								7.5		8
17	3.0			0.14			8.6										7.7
18	3.7			0.16			9.5										8
19	3.3			0.13			7.3										8
20	2.6			0.14			8.5										8
21	1.8			0.13			4.3										8
22	1.5			0.11			9.8										7.3
23	2.9			0.15			16.7							0.068			7.5
24	1.8			0.17			8.5								8.0		7
25	1.8			0.21			4.6										5.5
26	1.9			0.19			N/A										6
27	1.9			0.19			9.5								7.0		7.3
28	1.6			0.22			4.5								8.1		8
29	1.8			0.18			N/A								8.1		10
30	2.1			0.20			4.5								7.5		8.3
31	1.5			0.20			4.7								8.0		9.7

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.9: PARTICULATE REMOVAL PROFILE (JAN/87)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. A10	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	2.9			0.12			8.2										3
2	3.8			0.16			4.3								8.1		3.2
3	3.6			0.18			8.2										3
4	3.3			0.16			3.9										2.8
5	2.6			0.16			2.9								7.9		3.3
6	2.1			0.14			3.9								8.0		3.5
7	2.7			0.15			4.0								7.9		3
8	2.3			0.13			8.5								7.9		2.3
9	2.3			0.14			4.3								8.0		2.5
10	6.3			0.17			4.3										2.5
11	3.7			0.16			5.1										2.5
12	7.7			0.16			8.1										3
13	3.5			0.17			4.1								8.0		3
14	3.6			0.15			7.8								8.0		3.3
15	2.5			0.16			3.9								8.0		

TABLE 2.9 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	1.8			0.16			3.9								7.9		3
17	2.0			0.14			4.0										3
18	4.5			0.17			4.9										3
19	2.6			0.19			4.2								8.0		3
20	4.1			0.16			3.9							0.290	8.1		2
21	6.7			0.15			4.1								7.9		1.8
22	6.8			0.22			4.4								8.0		1.5
23	4.9			0.21			8.2								8.1		1.5
24	10.3			0.24			4.1										1.4
25	10.5			0.26			8.3										3.5
26	5.4			0.22			4.0								7.6		0.9
27	2.7			0.16			4.0								7.5		1
28	2.0			0.15			N/A								7.9		1.4
29	2.1			0.14			8.0								7.9		2.5
30	5.1			0.17			7.8								8.0		2.3
31	4.4			0.20			3.9										1.3

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets.
Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.10: PARTICULATE REMOVAL PROFILE (APR/87)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	3.2			0.19			12.4								8.3		3.4
2	11.7			0.15			8.6								8.2		3.4
3	13.9			0.15			7.9								8.0		3
4	10.6			0.27			8.9								8.3		2.5
5	19.9			0.34			10.2								8.2		4
6	15.2			0.23			8.7										3
7	13.5			0.17			N/A								8.3		4
8	8.5			0.16			7.7								8.2		
9	8.4			0.16			8.0										6
10	7.5			0.23			13.2								8.2		8
11	7.5			0.17			7.8										5
12	6.2			0.17			4.5										5
13	6.3			0.16			8.0								7.7		5
14	6.4			0.17			11.8								8.2		6
15	6.2			0.18			4.2							0.123	8.1		5

TABLE 2.10 (cont'd)

Page 2 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AIO	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^oC)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	5.3			0.25			8.7										5.5
17	5.1			0.19			4.3								8.1		
18	3.6			0.17			9.7										
19	3.3			0.19			4.5										7
20	2.6			0.16			7.6								8.0		7
21	2.5			0.17			3.8								8.1		7.5
22	2.1			0.16			N/A										8
23	2.1			0.16			4.6								8.0		8
24	1.9			0.17			3.6								8.2		8
25	1.9			0.17			4.1								8.3		8
26	1.9			0.19			4.6								8.3		8
27	1.7			0.20			3.9								8.2		8
28	1.5			0.16			8.0										8
29	1.6			0.17			4.1								8.1		6.5
30	1.7			0.16			4								8.0		8
31																	

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.11: PARTICULATE REMOVAL PROFILE (JUL/87)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (°C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/l	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	1.1			0.17			4.6										
2	1.1			0.20			4.5										7.3
3	2.1			0.21			6.1										9.5
4	1.2			0.21			5.1										11
5	1.1			0.19			4.9										10.5
6	1.2			0.31			N/A								7.9		11.5
7	1.3			0.25			4.7								8.0		14
8	1.2			0.21			5.8								8.0		15
9	1.0			0.22			13.9								8.0		
10	1.4			0.22			4.6								8.0		15
11	1.7			0.25			6.6								8.0		15
12	1.5			0.19			4.6								7.9		15
13	1.6			0.28			4.6								8.0		16.5
14	1.2			0.26			4.3						0.036	0.120	7.9		14.5
15	1.1			0.24			6.0								7.7		13.7

TABLE 2.11 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	1.2			0.23			4.4								7.6		10.3
17	1.2			0.26			5.5								7.7		11.5
18	1.2			0.26			N/A								7.7		12.5
19	1.3			0.29			5.6								7.8		12.2
20	1.2			0.23			9.9										13.5
21	1.3			0.21			4.1										14
22	1.2			0.21			8.0										14
23	1.3			0.25			4.0								7.8		14
24	1.4			0.21			4.1								7.9		15
25	1.2			0.19			9.1								7.7		
26	1.2			0.18			9.8								7.6		13.5
27	1.1			0.13			4.2										12.5
28	1.4			0.13			8.5								6.9		13
29	1.4			0.14			4.1								7		13.5
30	1.5			0.14			8.6								7.8		
31	1.4			0.24			8.9								8.2		13.5

NOTE: pH and Al residuals obtained from OWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 2.12: PARTICULATE REMOVAL PROFILE (OCT/87)

Page 1 of 2

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. AID	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^{o}C)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
1	0.78			0.10			8.3								7.6		13.7
2	6.8			0.15			4.9								7.6		13.5
3	2.6			0.11			9.8								7.6		9
4	1.3			0.09			5.0								7.6		7.6
5	1.3			0.11			3.9								7.2		5.5
6	1.3			0.13			4.7								7.2		6.5
7	3.7			0.13			4.9										7
8	2.7			0.10			4.9										7
9	1.3			0.13			N/A										8
10	2.1			0.18			4.8										8.5
11	1.3			0.13			6.6										7.8
12	1.3			0.13			6.1										6.8
13	1.7			0.12			4.5										8
14	1.5			0.13			N/A										8.3
15	0.97			0.14			4.6										10

TABLE 2.12 (cont'd)

DATE	TURBIDITY (NTU)				COLOUR (TCU)		ALUM	COAG. A10	(1)	(2)	(3)	(4)	METAL RES. Al (mg/L)		pH		TEMP. (^oC)
	Raw	Set.	Filter	Treat.	Raw	Treat.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Raw	Treat.	Raw	Treat.	
16	0.77			0.15			8.5										13
17	0.82			0.12			5.5										12.7
18	2.4			0.16			5.5										13
19	0.93			0.11			4.4										13
20	0.87			0.10			4.0										12.3
21	0.90			0.11			8.0										11.5
22	0.93			0.14			4.0										5
23	1.8	2.8		0.14			4.0								7.1		11
24	1.7	N/A		0.14			8.0								7.4		11
25	2.2	1.9		0.10			4.4										9
26	0.91	N/A		N/A			4.4								7.4		9.5
27	2	2		0.16			3.9								7.3		9
28	1.6	N/A		0.13			8.6								7.2		9.3
29	1.2	1.2		0.14			3.9								7.3		9
30	1.1	1.1		0.14			4.0								7.3		9
31	1.1	N/A		0.12			4.2								7.3		8.5

NOTE: pH and Al residuals obtained from DWSP, MOE Sampling Sheets and Daily Comparison - Cl^- or F^- Analyzer and Lab Test Sheets. Colour obtained from DWSP and MOE sampling sheets. Turbidity, alum dosage and temperature obtained from Daily Log Sheets.

N/A = Data Unavailable - calculated alum dosages not recorded due to lack of raw water pumpage data and/or aluminum sulphate usage.

TABLE 3.0: DISINFECTION SUMMARY

MONTH	CHEMICAL	1987						1986						1985					
		PRE-			POST-			PRE-			POST-			PRE-			POST-		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JAN	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.60	0.44	0.79	0.80	0.38	0.56	1.50	0.13	0.79	1.0	0.26	0.57	1.0	0.28	0.71	0.73	0.33	0.57
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F^- Dosage	2.0	0.7	1.1				1.80	0.62	1.15				2.26	0.68	1.5			
	F^- Res.	1.28	0.85	1.1				1.39	0.59	1.11				1.4	0.62	1.12			
FEB	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.80	0.32	0.79	0.99	0.27	0.56	0.99	0.54	0.77	0.73	0.28	0.56	1.07	0.27	0.68	0.75	0.40	0.58
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F^- Dosage	2.1	0.7	1.1				4.9	0.51	1.56				2.7	0.65	1.3			
	F^- Res.	N/A	N/A	N/A				N/A	N/A	N/A				2.70	0.76	1.21			
MAR	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.30	0.60	0.80	0.72	0.34	0.55	1.06	0.20	0.78	0.70	0.70	0.55	1.20	0.27	0.71	0.85	0.28	0.57
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F^- Dosage	1.6	0.64	1.1				N/A	N/A	N/A				2.5	0.65	1.4			
	F^- Res.	1.5	0.80	1.15				1.32	0.80	1.12				1.35	1.00	1.15			

NOTE: All data for pre and post free chlorine residual and F^- dosages obtained from Daily Log Sheets. Monthly pre and post free chlorine residual averages are calculated from the daily averages. All max. and min. values for pre and post free Cl_2 residual are absolute. Average monthly F^- residuals are calculated from three laboratory tests conducted daily. F^- residual data obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

N/A = Data Unavailable - F^- Dosage and F^- Residual not calculated due to no raw water pumpage data.

MONTH	CHEMICAL	1987						1986						1985					
		PRE-			POST-			PRE-			POST-			PRE-			POST-		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
APR	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.25	0.40	0.80	0.71	0.40	0.55	1.10	0.60	0.83	0.71	0.20	0.54	1.20	0.40	0.73	0.80	0.20	0.56
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F- Dosage	2.7	0.66	1.3				2.00	1.20	1.40				2.44	0.64	1.40			
	F- Res.	1.4	0.35	1.08				1.30	0.80	1.10				1.25	1.01	1.12			
MAY	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.03	0.60	0.80	0.74	0.45	0.55	1.76	0.26	0.83	0.66	0.25	0.56	0.88	0.32	0.72	0.66	0.33	0.56
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F- Dosage	2.7	0.56	1.2										2.26	0.65	1.40			
	F- Res.	1.35	0.78	1.16				1.37	0.78	1.16				1.60	0.45	1.11			
JUN	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.20	0.62	0.80	0.71	0.40	0.55	1.09	0.44	0.83	0.89	0.35	0.55	0.99	0.30	0.74	0.71	0.30	0.56
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F- Dosage	2.0	0.6	1.2				15.2	0.60	1.80				2.6	0.60	1.4			
	F- Res.	1.30	0.95	1.17				1.68	0.40	1.20				1.65	1.00	1.13			

NOTE: All data for pre and post free chlorine residual and F^- dosages obtained from Daily Log Sheets. Monthly pre and post free chlorine residual averages are calculated from the daily averages. All max. and min. values for pre and post free Cl_2 residual are absolute. Average monthly F^- residuals are calculated from three laboratory tests conducted daily. F^- residual data obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

TABLE 3.0 (cont'd.)

MONTH	CHEMICAL	1987						1986						1985					
		PRE-			POST-			PRE-			POST-			PRE-			POST-		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
JUL	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.21	0.36	0.80	0.74	0.39	0.56	1.15	0.31	0.83	0.70	0.37	0.54	1.06	0.55	0.79	0.68	0.40	0.55
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F^- Dosage	2.6	0.07	1.7				2.10	0.07	1.20				2.6	0.64	1.5			
	F^- Res.	1.5	0.85	1.14				1.37	0.87	1.10				1.50	0.74	1.06			
AUG	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.0	0.50	0.80	0.70	0.40	0.55	1.20	0.53	0.84	0.80	0.38	0.56	1.20	0.64	0.84	0.67	0.16	0.55
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F^- Dosage	2.2	0.67	1.1				2.30	0.68	1.38				2.40	0.73	1.60			
	F^- Res.	1.35	0.52	1.17				1.36	0.80	1.16				1.40	0.25	1.06			
SEP	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.08	0.62	0.81	0.75	0.44	0.55	1.25	0.35	0.83	0.85	0.35	0.55	1.16	0.55	0.83	0.73	0.40	0.57
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F^- Dosage	2.3	0.73	1.2				6.10	0.67	1.89				3.43	0.80	1.79			
	F^- Res.	2.0	0.6	1.1				1.34	0.68	1.08				1.35	0.81	1.11			

NOTE: All data for pre and post free chlorine residual and F^- dosages obtained from Daily Log Sheets. Monthly pre and post free chlorine residual averages are calculated from the daily averages. All max. and min. values for pre and post free Cl_2 residual are absolute. Average monthly F^- residuals are calculated from three laboratory tests conducted daily. F^- residual data obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

MONTH	CHEMICAL	1987						1986						1985					
		PRE-			POST-			PRE-			POST-			PRE-			POST-		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
OCT	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)	1.05	0.60	0.80	0.72	0.40	0.57	1.50	0.45	0.84	0.75	0.35	0.55	1.07	0.56	0.79	0.65	0.35	0.56
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F- Dosage	2.0	0.70	1.15				2.36	0.69	1.55				2.36	0.69	1.55			
	F- Res.	1.38	0.81	1.12				1.58	0.77	1.11				1.48	0.54	1.12			
NOV	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)							1.40	0.45	0.82	0.78	0.30	0.57	0.95	0.51	0.78	0.65	0.47	0.56
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F- Dosage							2.12	0.66	1.20				1.37	0.59	1.80			
	F- Res.							1.37	0.69	1.10				1.28	0.90	1.17			
DEC	Cl_2 Demand																		
	Cl_2 Dosage																		
	NH_3																		
	SO_2																		
	Cl_2 Res. (Free)							1.35	0.42	0.83	1.01	0.22	0.57	1.52	0.36	0.77	1.04	0.10	0.56
	Cl_2 Res. (Comb.)																		
	Cl_2 Res. (Total)																		
	F- Dosage							1.54	0.60	1.10				2.40	0.69	1.30			
	F- Res.							1.20	0.84	1.09				1.39	0.70	1.10			

NOTE: All data for pre and post free chlorine residual and F^- dosages obtained from Daily Log Sheets. Monthly pre and post free chlorine residual averages are calculated from the daily averages. All max. and min. values for pre and post free Cl_2 residual are absolute. Average monthly F^- residuals are calculated from three laboratory tests conducted daily. F^- residual data obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

TABLE 3.1: DISINFECTION PROFILE (JAN/85)

Page 1 of 1

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.76							0.59			N/A	1.18
2					0.69							0.57			1.47	1.11
3					0.71							0.58			1.96	1.14
4					0.73							0.56			1.40	1.19
5					0.68							0.54			1.42	1.22
6					0.68							0.57			1.41	1.20
7					0.71							0.56			1.95	1.20
8					0.76							0.63			N/A	1.14
9					0.73							0.56			2.09	1.15
10					0.73							0.58			0.68	1.20
11					0.76							0.58			N/A	1.05
12					0.70							0.58			0.70	1.10
13					0.70							0.56			2.21	1.28
14					0.66							0.52			1.32	1.17
15					0.71							0.56			2.08	1.21
16					0.70							0.56			1.42	1.14
17					0.67							0.56			1.31	1.18
18					0.71							0.57			1.38	1.13
19					0.72							0.58			2.26	1.07
20					0.73							0.58			1.44	1.10
21					0.62							0.53			1.27	1.04
22					0.75							0.59			2.18	1.20
23					0.63							0.56			1.03	1.18
24					0.64							0.56			1.56	0.92
25					0.63							0.55			1.29	1.12
26					0.82							0.63			0.74	1.14
27					0.68							0.55			2.17	1.08
28					0.74							0.61			1.38	1.06
29					0.74							0.60			N/A	0.68
30					0.74							0.59			1.49	0.72
31					0.68							0.56			1.44	1.40

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - No F^- added.

TABLE 3.2: DISINFECTION PROFILE (APR/85)

Page 1 of 1

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.76							0.55			1.30	1.16
2					0.76							0.56			1.28	1.16
3					0.74							0.57			1.41	1.15
4					0.72							0.56			1.90	1.14
5					0.72							0.57			1.46	1.18
6					0.68							0.53			0.80	1.14
7					0.70							0.56			1.71	1.13
8					0.76							0.59			0.65	1.14
9					0.69							0.60			1.97	1.08
10					0.69							0.56			1.34	1.08
11					0.64							0.58			N/A	1.08
12					0.73							0.61			1.33	1.11
13					0.73							0.53			1.40	1.19
14					0.76							0.56			1.56	1.15
15					0.78							0.57			1.31	1.14
16					0.74							0.54			2.44	1.07
17					0.74							0.57			2.19	1.16
18					0.76							0.54			1.28	1.12
19					0.72							0.51			1.32	1.07
20					0.76							0.54			1.33	1.08
21					0.71							0.55			2.02	1.04
22					0.74							0.58			0.64	1.15
23					0.73							0.52			0.69	1.13
24					0.77							0.54			1.89	1.12
25					0.72							0.55			0.64	1.11
26					0.76							0.59			1.94	1.11
27					0.73							0.56			1.36	1.11
28					0.71							0.55			2.10	1.12
29					0.71							0.55			0.66	1.12
30					0.73							0.57			1.39	1.09
31																

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - Refilled F^- tank

TABLE 3.3 DISINFECTION PROFILE (JUL/85)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.76							0.56			0.82	1.15
2					0.77							0.57			1.60	1.10
3					0.75							0.51			0.70	1.10
4					0.77							0.55			0.64	0.90
5					0.75							0.54			1.30	1.10
6					0.78							0.56			2.10	1.22
7					0.80							0.55			1.10	1.05
8					0.77							0.55			1.60	1.03
9					0.76							0.55			2.60	1.00
10					0.78							0.56			0.64	1.06
11					0.75							0.53			0.64	1.06
12					0.76							0.56			1.90	1.02
13					0.81							0.55			1.90	1.05
14					0.77							0.53			1.55	1.05
15					0.81							0.57			2.50	1.06
16					0.82							0.59			N/A	1.19
17					0.75							0.54			2.40	1.02
18					0.79							0.56			0.82	1.05
19					0.77							0.57			2.10	1.10
20					0.79							0.54			0.84	1.14
21					0.76							0.55			1.60	1.06
22					0.68							0.54			2.10	1.06
23					0.90							0.53			2.30	1.03
24					0.84							0.54			0.68	1.07
25					0.80							0.57			1.80	1.05
26					0.78							0.57			1.30	1.04
27					0.80							0.57			1.40	1.08
28					0.84							0.56			1.30	1.03
29					0.81							0.51			2.00	1.07
30					0.79							0.52			1.30	1.02
31					0.85							0.53			N/A	1.01

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - No F^- added

TABLE 3.4. DISINFECTION PROFILE (OCT/85)

Page 1 of 1

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.86							0.56			0.71	0.85
2					0.77							0.55			2.34	1.10
3					0.80							0.57			2.23	1.15
4					0.74							0.54			N/A	1.10
5					0.75							0.53			2.09	1.13
6					0.89							0.57			0.69	1.05
7					0.79							0.58			2.19	1.07
8					0.78							0.56			2.36	0.95
9					0.81							0.57			1.69	1.05
10					0.77							0.55			1.51	1.04
11					0.79							0.55			1.63	1.06
12					0.77							0.54			1.61	0.99
13					0.81							0.56			0.82	1.31
14					0.81							0.54			1.76	1.12
15					0.73							0.53			1.57	1.02
16					0.81							0.60			1.55	0.76
17					0.78							0.58			2.07	1.02
18					0.73							0.56			1.38	1.22
19					0.75							0.57			2.04	1.30
20					0.72							0.53			0.72	1.27
21					0.76							0.56			1.34	1.16
22					0.76							0.55			1.65	1.13
23					0.75							0.57			1.54	1.21
24					0.77							0.54			1.35	1.14
25					0.87							0.59			1.34	1.21
26					0.85							0.59			1.33	1.18
27					0.82							0.58			1.40	1.20
28					0.81							0.59			1.27	1.11
29					0.76							0.58			1.47	1.13
30					0.78							0.64			N/A	1.30
31					0.77							0.57			1.18	1.24

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A - Data Unavailable - No data recorded October 4, Refilled F^- tank October 30.

TABLE 3.5: DISINFECTION PROFILE (JAN/86)

Page 1 of 1

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.81							0.58			0.76	1.02
2					0.88							0.58			1.50	1.09
3					0.83							0.57			0.68	1.28
4					0.77							0.56			1.50	1.08
5					0.77							0.59			0.62	1.14
6					0.74							0.54			1.40	1.13
7					0.87							0.58			1.40	1.10
8					0.75							0.56			0.70	1.03
9					0.72							0.58			0.68	1.13
10					0.75							0.56			1.40	1.10
11					0.80							0.56			0.68	1.21
12					0.71							0.62			1.40	1.13
13					0.81							0.57			1.40	1.21
14					0.74							0.57			0.73	1.01
15					0.84							0.64			1.50	1.03
16					0.76							0.52			0.69	0.93
17					0.82							0.58			1.40	1.11
18					0.78							0.56			1.40	1.06
19					0.79							0.58			0.75	1.15
20					0.77							0.56			1.40	1.11
21					0.83							0.58			1.30	1.02
22					0.80							0.59			1.40	1.14
23					0.83							0.57			1.40	1.19
24					0.74							0.57			1.40	1.07
25					0.80							0.54			1.40	1.17
26					0.81							0.55			0.71	1.06
27					0.79							0.56			1.40	1.21
28					0.82							0.58			0.74	1.15
29					0.78							0.54			0.71	1.13
30					0.75							0.53			1.40	1.05
31					0.74							0.51			1.80	1.06

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

TABLE 3.6: DISINFECTION PROFILE (APR/86)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.71							0.51			N/A	1.13
2					0.85							0.59			N/A	1.17
3					0.79							0.53			N/A	1.23
4					0.81							0.57			N/A	1.10
5					0.79							0.53			N/A	1.07
6					0.76							0.51			N/A	1.07
7					0.84							0.57			N/A	1.09
8					0.80							0.51			N/A	0.84
9					0.72							0.49			N/A	0.91
10					0.82							0.53			N/A	1.14
11					0.79							0.55			0.66	1.12
12					0.84							0.52			1.30	1.23
13					0.87							0.56			1.30	1.10
14					0.87							0.57			1.26	1.20
15					0.81							0.54			1.22	1.13
16					0.84							0.56			1.90	1.10
17					0.86							0.55			0.60	1.03
18					0.90							0.54			N/A	1.10
19					0.85							0.50			N/A	1.10
20					0.92							0.60			N/A	N/A
21					0.84							0.54			N/A	N/A
22					0.87							0.58			N/A	N/A
23					0.85							0.57			N/A	N/A
24					0.81							0.51			N/A	N/A
25					0.86							0.56			N/A	N/A
26					0.80							0.53			N/A	N/A
27					0.85							0.57			N/A	N/A
28					0.88							0.45			N/A	N/A
29					0.90							0.53			N/A	N/A
30					0.89							0.56			N/A	N/A
31																

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - F^- dosage and F^- residual not calculated due to no raw water pumpage data.

TABLE 3.7: DISINFECTION PROFILE (JUL/86)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.92							0.56			1.48	
2					0.83							0.53			1.30	1.25
3					0.85							0.57			1.26	1.07
4					0.85							0.54			1.23	1.17
5					0.86							0.55			1.34	1.10
6					0.84							0.55			1.30	1.10
7					0.82							0.55			1.30	1.13
8					0.82							0.53			1.20	1.12
9					0.73							0.53			1.26	1.11
10					0.83							0.54			1.30	1.11
11					0.78							0.55			0.63	1.13
12					0.82							0.55			1.38	1.10
13					0.86							0.53			1.40	1.16
14					0.84							0.54			0.64	1.02
15					0.82							0.54			1.30	1.14
16					0.80							0.55			1.20	1.05
17					0.77							0.50			0.07	1.11
18					0.84							0.56			1.30	1.01
19					0.84							0.52			0.72	1.01
20					0.81							0.52			0.14	0.97
21					0.96							0.56			0.70	1.06
22					0.84							0.52			1.30	0.95
23					0.85							0.54			1.30	1.07
24					0.85							0.55				1.07
25					0.82							0.55			1.30	1.17
26					0.83							0.55			1.30	1.18
27					0.80							0.49			1.70	1.18
28					0.88							0.52			1.30	1.18
29					0.84							0.54			2.10	1.06
30					0.81							0.58			1.50	1.20
31					0.86							0.55			1.40	1.21

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - No F^- data recorded.

TABLE 3.8: DISINFECTION PROFILE (OCT/86)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.83							0.59			1.29	1.05
2					0.86							0.55			1.34	1.08
3					0.74							0.50			1.36	1.07
4					0.88							0.59			1.64	1.05
5					0.90							0.60			1.95	1.08
6					0.92							0.57			1.40	1.09
7					0.92							0.62			1.54	1.15
8					0.84							0.57			N/A	1.04
9					0.87							0.55			2.88	1.13
10					0.80							0.56			0.82	1.17
11					0.83							0.59			2.38	1.26
12					0.78							0.56			0.92	1.36
13					0.83							0.56			2.95	1.22
14					0.82							0.52			1.52	1.13
15					0.77							0.54			0.71	1.06
16					0.78							0.53			1.45	1.06
17					0.80							0.56			1.45	1.12
18					0.87							0.54			0.80	1.14
19					0.80							0.56			0.82	1.27
20					0.82							0.57			1.42	1.13
21					0.85							0.57			0.72	1.11
22					0.77							0.53			1.64	1.17
23					0.92							0.55			0.70	1.07
24					0.83							0.56			1.42	1.09
25					0.84							0.54			0.77	0.92
26					0.88							0.54			1.66	0.95
27					0.84							0.56			0.80	1.02
28					0.83							0.54			1.52	1.05
29					0.84							0.55			0.74	1.12
30					0.85							0.53			2.28	1.17
31					0.84							0.57			0.78	1.13

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - No F^- data recorded.

TABLE 3.9: DISINFECTION PROFILE (JAN/87)

DATE	PRE-CHLORINATION							POST CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.92							0.62			1.4	1.12
2					0.78							0.58			0.7	1.19
3					0.73							0.52			1.4	1.08
4					0.77							0.56			1.3	1.06
5					0.81							0.57			1.3	1.15
6					0.76							0.57			0.7	1.09
7					0.83							0.59			0.7	1.16
8					0.82							0.52			1.4	1.14
9					0.79							0.55			1.5	1.15
10					0.80							0.57			0.7	1.20
11					0.78							0.57			0.9	1.14
12					0.81							0.60			1.4	1.09
13					0.73							0.55			1.4	1.10
14					0.74							0.52			N/A	1.15
15					0.77							0.56			0.7	1.07
16					0.80							0.60			0.7	1.09
17					0.74							0.56			1.4	1.12
18					0.85							0.58			0.8	1.13
19					0.78							0.59			0.7	1.17
20					0.76							0.58			0.7	1.11
21					0.80							0.59			1.4	1.16
22					0.75							0.53			N/A	0.85
23					0.82							0.53			1.4	1.09
24					0.68							0.52			0.7	1.19
25					0.84							0.57			1.4	1.02
26					0.87							0.58			0.7	1.04
27					0.79							0.56			2.0	1.09
28					0.84							0.61			0.7	1.03
29					0.76							0.55			1.3	1.09
30					0.76							0.56			1.3	1.09
31					0.76							0.55			1.3	1.07

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A - Data Unavailable - No F^- added.

TABLE 3.10: DISINFECTION PROFILE (APR/87)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.82							0.53			1.4	1.15
2					0.83							0.54			0.73	1.15
3					0.90							0.58			0.66	1.00
4					0.78							0.52			N/A	0.45
5					0.85							0.53			N/A	N/A
6					0.84							0.56			0.73	0.95
7					0.76							0.55			2.03	0.90
8					0.80							0.57			1.3	1.03
9					0.79							0.54			0.67	1.10
10					0.77							0.53			N/A	N/A
11					0.81							0.53			N/A	N/A
12					0.78							0.55			N/A	N/A
13					0.78							0.54			N/A	N/A
14					0.74							0.55			0.66	N/A
15					0.75							0.60			1.4	1.03
16					0.77							0.59			2.2	1.07
17					0.82							0.58			1.5	1.00
18					0.79							0.57			1.6	1.18
19					0.83							0.56			1.5	1.23
20					0.77							0.54			1.3	1.20
21					0.81							0.55			1.3	1.28
22					0.84							0.59			1.4	1.04
23					0.77							0.54			0.8	1.20
24					0.78							0.58			1.5	1.14
25					0.79							0.54			1.4	1.11
26					0.78							0.55			1.5	1.13
27					0.81							0.58			1.3	1.08
28					0.78							0.53			1.3	1.20
29					0.79							0.53			1.4	1.16
30					0.80							0.57			2.7	1.20
31																

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A = Data Unavailable - No F^- added.

TABLE 3.11 DISINFECTION PROFILE (JUL/87)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.79							0.56			1.6	1.10
2					0.77							0.57			0.7	1.20
3					0.82							0.52			1.0	1.17
4					0.67							0.53			0.9	1.14
5					0.82							0.55			0.82	1.16
6					0.79							0.51			2.0	1.19
7					0.76							0.55			0.8	1.23
8					0.84							0.58			0.98	1.19
9					0.85							0.56			1.6	1.13
10					0.83							0.58			1.5	1.08
11					0.76							0.59			1.11	1.13
12					0.87							0.60			0.77	1.02
13					0.78							0.59			1.6	1.28
14					0.78							0.57			1.5	1.07
15					0.77							0.53			1.0	1.13
16					0.76							0.57			1.5	1.12
17					0.85							0.57			0.9	1.16
18					0.79							0.54			2.6	1.20
19					0.76							0.58			0.9	1.06
20					0.84							0.55			1.7	1.03
21					0.80							0.54			1.4	1.13
22					0.79							0.52			0.07	1.20
23					0.82							0.53			0.7	0.97
24					0.87							0.59			0.68	1.15
25					0.75							0.52			1.5	1.07
26					0.79							0.60			1.6	1.04
27					0.82							0.55			2.1	1.11
28					0.79							0.55			1.4	1.22
29					0.81							0.54			1.4	1.29
30					0.84							0.57			0.7	1.22
31					0.82							0.54			1.5	1.11

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

TABLE 3.12 DISINFECTION PROFILE (OCT/87)

DATE	PRE-CHLORINATION							POST-CHLORINATION							FLUORIDE	
	Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Cl_2		NH_3	SO_2	RESIDUAL Cl_2			Dos.	Res.
	Dem.	Dos.*			Free	Comb.	Total	Dem.	Dos.+			Free	Comb.	Total		
1					0.79							0.58			1.39	0.97
2					0.79							0.55			0.82	1.22
3					0.82							0.61			1.65	1.10
4					0.82							0.63			0.84	0.99
5					0.80							0.63			1.30	1.17
6					0.79							0.54			0.78	1.11
7					0.81							0.55			0.83	1.15
8					0.85							0.59			0.83	1.16
9					0.85							0.58			1.67	1.32
10					0.78							0.55			0.81	1.07
11					0.80							0.60			N/A	1.13
12					0.80							0.55			2.00	1.11
13					0.77							0.52			0.76	1.07
14					0.79							0.56			0.76	1.09
15					0.77							0.53			1.60	1.06
16					0.76							0.54			0.71	1.20
17					0.78							0.55			1.85	1.09
18					0.83							0.56			0.92	1.24
19					0.83							0.56			0.74	1.19
20					0.78							0.55			1.33	1.22
21					0.83							0.58			0.67	1.12
22					0.85							0.57			1.36	1.08
23					0.79							0.55			1.30	1.11
24					0.74							0.53			1.40	1.06
25					0.79							0.57			1.47	0.90
26					0.80							0.58			0.73	1.16
27					0.77							0.56			1.30	1.07
28					0.76							0.57			1.44	1.20
29					0.78							0.57			1.30	1.15
30					0.76							0.60			1.33	1.11
31					0.82							0.54			0.70	1.10

NOTE: Pre and post chlorine data are daily averages obtained from Daily Log Sheets. Fluoride dosage calculated from daily hydrofluosilicic acid usage divided by the raw water pumpage obtained from Daily Log Sheet. Fluoride residuals are averages of three laboratory tests conducted daily and are obtained from Oshawa Water Supply Plant - Treated Water Fluoride Levels Sheets.

* Sufficient chlorine is added to obtain a free chlorine residual of 0.8 to 1.0 mg/L.
+ Sufficient chlorine is added to obtain a free chlorine residual of 0.5 to 0.6 mg/L.

N/A - Data Unavailable - No F^- added.

TABLE 4.0: WATER QUALITY (1987 Summary)

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE 87/05/11	87/06/09	87/07/14	87/08/11							
1,1 DICHLOROETHANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1,1 DICHLOROETHYLENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1,2 DICHLOROBENZENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1,2 DICHLOROETHANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1,2 DICHLOROPROPANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1,3 DICHLOROBENZENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1,4 DICHLOROBENZENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
111, TRICHLOROETHANE	UG/L	R	.000 <W	.080 <T	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
112 TRICHLOROETHANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
1122 TETRACHLOROETHANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
123 TRICHLOROBENZENE	NG/L	R	5.000 <W	5.000 <W	24.000 <T	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
1234 TETRACHLOROBENZENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							

Footnotes at end of table

TABLE 4.0 (cont'd)

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		87/05/11	87/06/09	87/07/14	87/08/11							
1235 TETRACHLOROBENZENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
124 TRICHLOROBENZENE	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
1245 TETRACHLOROBENZENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
135 TRICHLOROBENZENE	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
2,4 D PROPIONIC ACID	NG/L	R		100.00 <W									
		T		100.00 <W									
2,4,5-TRICHLOROBUTYRIC ACID (2,4,5-T)	NG/L	R		50.000 <W									
		T		50.000 <W									
2,4-DICHLOROBUTYRIC ACID (2,4-D)	NG/L	R		100.00 <W									
		T		100.00 <W									
234 TRICHLOROPHENOL	NG/L	R		100.00 <W									
		T		100.00 <W									
2345 TETRACHLOROPHENOL	NG/L	R		20.000 <W									
		T		20.000 <W									
2356 TETRACHLOROPHENOL	NG/L	R		10.000 <W									
		T		10.000 <W									
236 TRICHLOROTOLUENE	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							

TABLE 4.0 (cont'd)

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
24-DICHLORORPHENOXYBUTYRIC ACID (24-DB)	NG/L	R		200.00 <W									
		T		200.00 <W									
245 TRICHLOROPHENOL	NG/L	R		100.00 <W									
		T		100.00 <W									
245 TRICHLOROTOLUENE	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
246 TRICHLOROPHENOL	NG/L	R		20.000 <W									
		T		20.000 <W									
26A TRICHLOROTOLUENE	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
ALACHLOR	NG/L	R	500.00 <W	500.00 <W	500.00 <W	500.00 <W							
		T	500.00 <W	500.00 <W	500.00 <W	500.00 <W							
ALDRIN	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
ALKALINITY	MG/L-CAC	R	99.30	99.50	101.80	94.700							
		T	93.700	94.200	95.400	88.700							
ALPHA CHLORDANE	NG/L	R	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
		T	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
ALPHA HEXACHLOROCYCLOHEXANE (BHC)	NG/L	R	3.000 <T	3.000 <T	1.000 <W	2.000 <T							
		T	1.000 <T	2.000 <T	4.000 <T	2.000 <T							
ALUMINUM	MG/L-AL	R	.021	.004 <	.036	.063							
		T	.086	.045	.120	.180							
AMETRINE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							

Footnotes at end of table

TABLE 4.0 (cont'd)

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
AMINOCARB	NG/L	R		.000 'NP									
		T		.000 'NP									
AMMONIUM TOTAL	MG/L-N	R	.032	.006 <T	.050	.038							
		T	.004 <T	.002 <T	.002 <T	.006 <T							
ARSENIC	MG/L-AS	R	.001 <	.001 <	.001 <	.001 <							
		T	.001 <	.001 <	.001 <	.001 <							
ATRATONE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
ATRAZINE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
BARIUM	MG/L-BA	R	.020	.021	.024	.020							
		T	.020	.020	.024	.019							
BENOMYL	NG/L	R		.000 'NP									
		T		.000 'NP									
BENZENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
BERYLLIUM	MG/L-BE	R	.001 <	.001 <	.001 <	.001 <							
		T	.001 <	.001 <	.001 <	.001 <							
BETA HEXACHLOROCYCLOHEXANE (BHC)	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
BLADEX	NG/L	R	100.00 <W	100.00 <W	100.00 <W	100.00 <W							
		T	100.00 <W	100.00 <W	100.00 <W	100.00 <W							

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
BORON	MG/L-BO	R	.030 <T	.030 <W	.020 <T	.020 <T							
		T	.030 <T	.040 <W	.020 <T	.030 <T							
BROMOFORM	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.400 <T	.000 <W	.000 <W							
BUX (METALKAMATE)	NG/L	R		.000 'NP									
		T		.000 'NP									
CADMIUM	UG/L-CD	R	.300 <	.300 <	.300 <	.300 <							
		T	.300 <	.300 <	.300 <	.300 <							
CALCIUM	MG/L-CA	R	39.200	40.800	41.000	37.200							
		T	40.000	42.200	41.400	37.800							
CARBOFURAN	NG/L	R		2000.0 <W									
		T		2000.0 <W									
CARBON TETRACHLORIDE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
CHLORIDE	MG/L-CL-	R	24.500	24.000	23.500	23.500							
		T	25.500	25.000	25.000	25.500							
CHLOROBENZENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
CHLORODIBROMOMETHANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	6.000	5.900	6.000	6.900							
CHLOROFORM	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	15.000	16.200	22.000	25.800							
CHROMIUM	MG/L-CR	R	.001	.001 <	.002	.001 <							
		T	.001 <	.001 <	.001	.001 <							

Footnotes at end of table

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
CICP (CHLORPROPHAM)	NG/L	R		2000.0 <W									
		T		2000.0 <W									
COBALT	MG/L-CO	R	.001 <	.001 <	.001	.001 <							
		T	.001 <	.001 <	.001 <	.001 <							
COLOUR	HZU	R	1.000 <T	.500 <W	2.000 <T	2.000 <T							
		T	1.000 <T	.500 <W	.500 <T	.500 <T							
CONDUCTIVITY	UMHO/CM	R	332.00	334.00	329.00	312.00							
		T	337.00	339.00	331.00	320.00							
COPPER	MG/L-CU	R	.004	.001	.008	.001							
		T	.002	.002	.007	.002							
CYANIDE	MG/L-CN	R	.001 <W	.001 <W	.001 <W	.001 <W							
		T	.001 <W	.001 <W	.001 <W	.001 <W							
DIALLATE	NG/L	R		2000.0 <W									
		T		2000.0 <W									
DIAZINON	NG/L	R		20.000 <W									
		T		20.000 <W									
DICAMBA	NG/L	R		50.000 <W									
		T		50.000 <W									
DICHLOROBROMOMETHANE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	11.000	12.500	14.000	15.400							
DICHLOROVOS	NG/L	R		20.000 <W									
		T		20.000 <W									

TABLE 4.0 (cont'd)

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
DIELDRIN	NG/L	R	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
		T	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
DURSBAN	NG/L	R		20.000 <W									
		T		20.000 <W									
ENDOSULFAN 1 (THIODAN I)	NG/L	R	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
		T	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
ENDOSULFAN 2 (THIODAN II)	NG/L	R	4.000 <W	4.000 <W	4.000 <W	4.000 <W							
		T	4.000 <W	4.000 <W	4.000 <W	4.000 <W							
ENDOSULFAN SULPHATE (THIODAN SULPHATE)	NG/L	R	4.000 <W	4.000 <W	4.000 <W	4.000 <W							
		T	4.000 <W	4.000 <W	4.000 <W	4.000 <W							
ENDRIN	NG/L	R	4.000 <W	4.000 <W	4.000 <W	4.000 <W							
		T	4.000 <W	4.000 <W	4.000 <W	4.000 <W							
EPTAM	NG/L	R		2000.0 <W									
		T		2000.0 <W									
ETHION	NG/L	R		20.000 <W									
		T		20.000 <W									
ETHLYENE DIBROMIDE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
ETHYLBENZENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
FECAL COLIFORM MEMBRANE FILTRATION	CT/100ML	R	.000	.000	2.000 <	36.000							
		T											
FIELD COMBINED CHLORINE RESIDUAL	MG/L-CL	R											
		T	.200	.300	.300	.200							

Footnotes at end of table

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
FIELD FREE CHLORINE RESIDUAL	MG/L-CL	R											
		T	.800	.700	.700	.900							
FIELD PH		R	7.900	7.900	8.000	8.000							
		T	7.500	7.400	7.500	7.600							
FIELD TEMPERATURE	DEG.C	R	7.000	8.000	13.000	20.000							
		T	7.000	8.000	13.500	21.000							
FIELD TOTAL CHLORINE RESIDUAL	MG/L-CL	R											
		T	1.000	1.000	1.000	1.100							
FIELD TURBIDITY	FTU	R	1.040	1.230	1.690	4.800							
		T	.130	.130	.310	.180							
FLUORIDE	MG/L-F	R	.150	.120	.160	.130							
		T	1.120	1.170	1.230	1.100							
GAMMA CHLORDANE	NG/L	R	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
		T	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
GAMMA HEXACHLOROCYCLOHEXANE (LINDANE)	NG/L	R	1.000 <W	4.000 <T	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <T	1.000 <T	1.000 <W							
GUTHION	NG/L	R		.000 !NP									
		T		.000 !NP									
HARDNESS	MG/L-CAC	R	131.00	137.00	135.00	127.00							
		T	132.00	140.00	137.00	128.00							
HEPTACHLOR	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
HEPTACHLOR EPOXIDE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
HEXACHLOROBENZENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
HEXACHLOROBUTADIENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
HEXACHLOROETHANE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	2.000 <T							
IPC	NG/L	R		2000.0 <W									
		T		2000.0 <W									
IRON	MG/L-FE	R	.012	.050 <	.001 <	.037							
		T	.001 <	.050 <	.001 <	.003							
LEAD	MG/L-PB	R	.003 <	.003 <	.003 <	.003 <							
		T	.003 <	.003 <	.003 <	.003 <							
M-XYLENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
MAGNESIUM	MG/L-MG	R	7.900	8.500	8.100	8.300							
		T	7.900	8.300	8.200	8.200							
MALATHION	NG/L	R		20.000 <W									
		T		20.000 <W									
MANGANESE	MG/L-MN	R	.001	.002	.003	.003							
		T	.001 <W	.001 <W	.001	.001 <W							
MERCURY	UG/L-HG	R	.010	.010	.010	.010							
		T	.010	.010	.010	.010							

Footnotes at end of table

TABLE 4.0 (cont'd)

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
METHOXYCHLOR	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
METHYL PARATHION	NG/L	R		50.000 <W									
		T		50.000 <W									
METHYLENE CHLORIDE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
METHYLTRITHION	NG/L	R		20.000 <W									
		T		20.000 <W									
METOLACHLOR	NG/L	R	500.00 <W	500.00 <W	500.00 <W	500.00 <W							
		T	500.00 <W	500.00 <W	500.00 <W	500.00 <W							
MEVINPHOS	NG/L	R		20.000 <W									
		T		20.000 <W									
MIREX	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
MOLYBDENUM	MG/L-MO	R	.001	.001	.001	.001							
		T	.001	.001	.001	.001							
NICKEL	MG/L-NI	R	.002 <	.002 <	.002 <	.002 <							
		T	.002 <	.002 <	.002 <	.002 <							
NITRITE	MG/L-N	R	.003 <T	.048	.005	.006							
		T	.001 <T	.002 <T	.001 <T	.001 <W							
NITROGEN TOTAL KJELDAHL	MG/L-N	R	.390	.160	.310	.230							
		T	.120	.130	.170	.170							

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
O,P-DDD	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
O,P-DDT	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
O-XYLENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
OCTACHLOROSTYRENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
OXYCHLORDANE	NG/L	R	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
		T	2.000 <W	2.000 <W	2.000 <W	2.000 <W							
P-XYLENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
P/A BOTTLE	0=ABSENT	R											
		T	.000	.000	.000	.000							
PARATHION	NG/L	R		20.000 <W									
		T		20.000 <W									
PCB	NG/L	R	20.000 <W	20.000 <W	20.000 <W	20.000 <W							
		T	20.000 <W	20.000 <W	20.000 <W	20.000 <W							
PENTACHLOROBENZENE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
PENTACHLOROPHENOL	NG/L	R		10.000 <W									
		T		10.000 <W									
PH		R	8.280	8.220	8.280	8.290							
		T	8.040	7.940	7.990	7.980							

Footnotes at end of table

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
PHENOLICS (UNFILTERED REACTIVE)		R	.200 <T	.400 <T	.200 <T	.200 <W							
		T	.200 <T	.400 <T	.200 <W	.200 <W							
PHORATE (THIMET)	NG/L	R		20.000 <W									
		T		20.000 <W									
PHOSPHORUS FIL REACT	MG/L-P	R	.004	.004	.001 <T	.002							
		T	.000 <T	.000 <T	.000 <W	.000 <T							
PHOSPHORUS TOTAL	MG/L-P	R	.013	.008 <T	.019	.011							
		T	.002 <T	.004 <T	.006 <T	.002 <T							
PICHLORAM	NG/L	R		.000 'NP									
		T		.000 'NP									
PPDDE	NG/L	R	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
		T	1.000 <W	1.000 <W	1.000 <W	1.000 <W							
PPDDT	NG/L	R	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
		T	5.000 <W	5.000 <W	5.000 <W	5.000 <W							
PROMETONE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
PROMETRYNE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
PROPAZINE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
PROPOXUR (BAYGON)	NG/L	R		2000.0 <W									
		T		2000.0 <W									

OSHAWA WATER TREATMENT PLANT OWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
RELDAN	MG/L	R		20.000 <W									
		T		20.000 <W									
RONNEL	NG/L	R		20.000 <W									
		T		20.000 <W									
SELENIUM	MG/L-SE	R	.001 <	.001 <	.001 <	.001 <							
		T	.001 <	.001 <	.001 <	.001 <							
SENCOR (METRIBUZIN)	NG/L	R	100.00 <W	100.00 <W	100.00 <W	100.00 <W							
		T	100.00 <W	100.00 <W	100.00 <W	100.00 <W							
SEVIN (CARBARYL)	NG/L	R		200.00 <W									
		T		200.00 <W									
SILVEX (2,4,5-TP)	NG/L	R		20.000 <W									
		T		20.000 <W									
SIMAZINE	NG/L	R	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
		T	50.000 <W	50.000 <W	50.000 <W	50.000 <W							
SODIUM	MG/L-NA	R	12.400	12.600	12.000	12.400							
		T	12.800	12.800	12.000	12.000							
STANDARD PLATE COUNT MEMBRANE FILT.	CT/ML	R	74.000	240.00	330.00	2400.0 >							
		T	2.000	.000	6.000	35.000							
STRONTIUM	MG/L-SR	R	.160	.170	.180	.160							
		T	.160	.170	.190	.150							
SUTAN (BUTYLATE)	NG/L	R		2000.0 <W									
		T		2000.0 <W									
TETRACHLOROETHYLENE	UG/L	R	.000 <W	.100 <T	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							

Footnotes at end of table

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
TIN	MG/L-SN	R	.000 'NP	.000 'NP	.000 'NP	.000 'NP							
		T	.000 'NP	.000 'NP	.000 'NP	.000 'NP							
TOLUENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
TOTAL COLIFORM BACKGROUND MF	CT/100ML	R	136.00	1100.0	2100.0	4000.0							
		T	.000	.000	.000	2.000							
TOTAL COLIFORM MEMBRANE FILTRATION	CT/100ML	R	27.000	16.000 A3C	4.000 A3C	36.000 A3C							
		T	.000	.000	.000	.000							
TOTAL NITRATES	MG/L-N	R	.350	.440	.250	.140							
		T	.345	.395	.255	.135							
TOTAL SOLIDS	MG/L	R	216.00 CRO	217.00 CRO	214.00 CRO	203.00 CRO							
		T	219.00 CRO	220.00 CRO	215.00 CRO	208.00 CRO							
TOTAL TRIHALOMETHANES	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	32.000	35.000	42.000	48.100							
TOXAPHENE	NG/L	R	.000 'NP	.000 'NP	.000 'NP	.000 'NP							
		T	.000 'NP	.000 'NP	.000 'NP	.000 'NP							
TRANS 1,2 DICHLOROETHYLENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
TRICHLOROETHYLENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							
TRIFLUOROCHLOROTOLUENE	UG/L	R	.000 <W	.000 <W	.000 <W	.000 <W							
		T	.000 <W	.000 <W	.000 <W	.000 <W							

TABLE 4.0 (cont'd)

OSHAWA WATER TREATMENT PLANT DWSP RESULTS

PARAMETERS	UNITS		SAMPLE DATE										
			87/05/11	87/06/09	87/07/14	87/08/11							
TURBIDITY	FTU	R	1.010	.140	.940	3.100							
		T	.300	.050	.140	.230							
URANIUM	UG/L-U	R	.350 <T	.340	.260	.350							
		T	.390 <T	.300	.310	.320							
VANADIUM	MG/L-V	R	.001 <W	.001 <W	.001	.001 <W							
		T	.001 <W	.001 <W	.001	.001 <W							
ZINC	MG/L-ZN	R	.001 <W	.002	.020 <	.007							
		T	.001 <W	.002	.020 <	.005							

TABLE 4.0 - FOOTNOTES

1 = see individual footnotes for agency of guideline origin
c = California State Department of Health action level
d = OWDO for DDT (contains other isomers such as OPDDT and PPDDT)
e = USEPA ambient guideline
ea = United States Environmental Protection Agency (USEPA) ambient level for endosulfan (contains other isomers)
ep = USEPA proposed maximum contaminant level for drinking water
g = suggested Health and Welfare Canada/Ontario Ministry of the Environment guideline value
h = World Health Organization (WHO) guideline
h* = World Health Organization (WHO) odour threshold
mg/L = milligrams per litre, parts per million (ppm)
ng/L = nanograms per litre, parts per trillion (ppt)
Presence/Absence = microbiological test to indicate presence or absence of coliform bacteria
R = raw water
T = treated drinking water
t = ODWO interim maximum acceptable concentration (IMAC)
ug/L = micrograms per litre, parts per billon (ppb)
y = New York State (taste and odour) proposed drinking water guideline
++ = total trihalomethanes
+++ = combined total: heptachlor and heptachlor epoxide
* = if other than DWSP detection limit
** = total of aldrin and dieldrin
*** = chlordane is a mixture of alpha and gamma isomers
! = Ministry of the Environment and Health and Welfare Canada (IMAC)
- = no quantifiable result
G = ODWO suggested guideline

TABLE 5.0. BACTERIOLOGICAL TESTING (1985)

MONTH	R/T	TOTAL COLIFORM					FECAL COLIFORM					FECAL STREPTOCOCCUS				Present/Absent Test	
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500	Absent	1	2-50	>50	Absent	Present
JAN	R				4				1	3			2	2			
	T															2	
FEB	R				1					1					1		
	T						1										1 *
MAR	R				2			1		1			1	1			
	T															2	
APR	R			1	1					2				2			
	T						1									2	1
MAY	R				2			2						2			
	T		2													2	
JUN	R		3					3						3			
	T															3	
JUL	R			2				1	1					2			
	T															2	
AUG	R				2				2					1			
	T															2	
SEP	R		3					3					3				
	T															2	1
OCT	R			2				1		1				2			
	T															2	
NOV	R			1	2				1	1				2			
	T															2	
OEC	R				4					4				4			
	T															4	

NOTE: All results are for 100 mL samples. Tests carried out at MOE lab, Resources Road.
Data obtained from MOE Sampling Sheets.

R = Raw; T = Treated

* Coliform present
Fecal coliform absent

TABLE 5.1: BACTERIOLOGICAL TESTING (1986)

MONTH	R/T	TOTAL COLIFORM					FECAL COLIFORM.					FECAL STREPTOCOCCUS				Present/Absent Test	
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500	Absent	1	2-50	>50	Absent	Present
JAN	R			1	2			1	2					2			
	T															3	
FEB	R			1	1			2						2			
	T															2	
MAR	R				1				1					1			
	T															1	
APR	R				3				3					3			
	T															3	
MAY	R			2				2						2			
	T															2	
JUN	R		2					2									
	T															2	
JUL	R			2				2									
	T															3	
AUG	R		1	1				1	1								
	T															2	
SEP	R																
	T															2	
OCT	R			1	1			1	1								
	T															2	
NOV	R			2	2			2		2							
	T															4	
DEC	R			1	2					3							
	T															3	

NOTE: All results are for 100 mL samples. Tests carried out at MOE lab, Resources Road. Data obtained from MOE Sampling Sheets.

R = Raw; T = Treated

TABLE 5.2: BACTERIOLOGICAL TESTING (1987)

Page 1 of 1

MONTH	R/T	TOTAL COLIFORM					FECAL COLIFORM					FECAL STREPTOCOCCUS				Present/Absent Test	
		Absent	1-5	6-100	101-5000	>5000	Absent	1-5	6-10	11-500	>500	Absent	1	2-50	>50	Absent	Present
JAN	R		1	1				2						1			
	T															1	
FEB	R			2				1	1								
	T															2	
MAR	R			2				1	1								
	T															2	
APR	R			2	1			2		1							
	T															3	
MAY	R			2				1									
	T															2	
JUN	R		1	2													
	T															3	
JUL	R			2				2									
	T															2	
AUG	R			1	1				1	1							
	T															2	
SEP	R			1	1			2									
	T															2	
OCT	R			1				1									
	T															1	
NOV	R																
	T																
DEC	R																
	T																

NOTE: All results are for 100 mL samples. Tests carried out at MOE lab, Resources Road. Data obtained from MOE Sampling Sheets.

R = Raw; T = Treated

TABLE 6.0: ONTARIO DRINKING WATER EXCEEDENCES (TREATED WATER AT PLANT)

Page 1 of 1

DATE	PARAMETER	MEASURED PARAMETER	OBJECTIVE LIMIT
01/03/85	Turbidity	1.01 NTU *	1 NTU
08/04/85	Turbidity	1.01 NTU *	1 NTU
09/04/85	Turbidity	1.30 NTU	1 NTU

NOTE: Turbidity values are bi-hourly readings reported on the Daily Log Sheet (not daily averages).

* 1.01 NTU may not be an exceedence since the difference of 0.01 NTU is not within the precision of the instrument.

APPENDIX B

FILTER BACKWASHING GUIDELINES AND PROCEDURE

OSHAWA WATER SUPPLY PLANT

Filter Backwash Automatic Program - New Plant

This automatic program controls backwashing of the 6 filters. Only one filter may be washed at a time. A request to wash a filter is made via a message from the CPU (central processing unit), or via a request on the RTU (remote terminal unit) keyboard.

The sequence involved in washing filter 'X' is described below:

1. Check the following conditions:

   .1 All output devices to be used by the automatic program are in CPU-AUTO (central processing unit automatic) mode.
   .2 Clearwell level is above high advisory limit.

   If both of above conditions are true, then proceed to step 2. Otherwise, generate an alarm and cancel the wash request.

2. Set low level alarm to be a status input, ie. non-alarm, input point.

3. Close filter influent gate.

4. Wait until the three following conditions are met:

   .1 Filter influent gate is fully closed.
   .2 Filter level is low, i.e. digital input is on.
   .3 Filter effluent flow is low, ie. is less than 250 m^3/h.

   If the above conditions are not met within the expected time interval (5.0 min.), then generate an alarm and continue to wait.

5. Open the filter drain gate.

6. When drain gate is fully open, open filter agitator valve.

Filter Backwash Automatic Program - New Plant (cont'd)

7. When filter agitator valve is fully open, mark the time and open filter wash water valve. The program will close the filter agitator valve after it has been open for the required time period (5 min.), independently of the rest of the program.

8. When the filter wash water valve is open, check that the washwater pump is in remote. If the pump is in remote mode, then ramp open the washwater flow control valve from 0 to the 'low rate'. (The ramp rate is 100, the low flow rate set point is 760 m^3/h). Opening the washwater flow valve automatically starts the washwater pump. The washwater pump is expected to come on when the valve position reaches 650 m^3/h. If the washwater pump does not start, then generate an alarm and suspend the program.

9. After washwater flow rate has been set to 'low flow' rate, wait for 'low rate wash time' (5.0 min.).

10. Ramp up wash water flow analog output from 'low rate' to 'high rate'. (The high flow rate set point is 1900 m^3/h).

11. After washwater flow rate has been set to 'high flow' rate, wait until one of the following conditions is met:

    .1 High flow wash time (5.0 min.) has elapsed.
    .2 Washwater turbidity is less than or equal to turbidity limit (50 NTU) if the continuous backwash water turbidimeter is operational.

12. Ramp the washwater flow analog output down to the 'low flow' rate. (The ramp rate is 100, the low flow rate set point is 760 m^3/h).

13. After washwater flow rate has been set to 'low flow', wait for 'second low rate wash time' (2.0 min.).

14. Ramp the washwater flow analog output down to 0, which will cause the wash water pump to go off. If the wash water pump does not go off, generate an alarm and suspend the program.

Filter Backwash Automatic Program - New Plant (cont'd)

15. When the washwater analog output is ramped down to 0, and the washwater pump is off, then close the filter drain gate valve.

16. When the filter drain gate valve is closed, then close the filter washwater valve.

17. When the filter washwater valve is fully closed, then set the filter low level alarm to be an alarm digital input. Indicate that the wash is complete so that the operator can open the influent gate and put the filter back into service.

NOTES:

During the wash, the clearwell level is monitored. If the level goes into low alarm, then the wash cycle is suspended, and an alarm is generated.

After step 5 has been reached in the wash sequence, the filter effluent flow is monitored continuously. If the flow is greater than the value of 250 m^3/h, then an alarm is generated and the wash is suspended.

During the wash, the washwater flow analog input is compared with the washwater flow analog output. If there is a significant difference, then an alarm is generated and the wash is suspended.

If the automatic program wishes to start/stop or open/close a digital output, or wishes to change an analog output device, but the device is not in CPU-AUTO mode or fails to respond, then the wash cycle is suspended, and an alarm is generated; and when the device error is corrected, the automatic program will proceed.

The program continually monitors the states (ie. on/off or opened/closed) of the devices involved in the active wash cycle. If a device is found to be in the wrong state, then the wash cycle is suspended, and an alarm is generated.

Filter Backwash Automatic Program - New Plant (cont'd)

The automatic program may be suspended because of the following reasons:

1. A device (digital output, analog output or digital input) is in error, eg. failed to start/stop/respond.
2. Flag #17 was set via a message from CCF, or via a command from the RTU control panel.

When the automatic program is suspended, then the program does not take any further actions, unless it was suspended during steps 7, 8, 9, 10 or 11 (ie. while the wash water flow valve is open). In that case, when the program is suspended, the washwater flow valve is ramped down to 0 flow, then if the automatic program is resumed, it starts back at step 7.

If the automatic program is suspended because of a device error and then the fault is rectified, the program will resume. If a request is made to suspend the automatic program by setting flag #17, then the program will resume when flag #17 is cleared.

While a backwash cycle is underway, the low level alarm is considered to be a status point. When there is no backwash underway, it is considered to be an alarm point.

If an error occurs during the wash cycle, the cycle is suspended, an alarm is generated, and a code to indicate the nature of the alarm is put into variable #24. If the alarm code indicates that a digital input or output point, or analog output point, is in error (eg. is not in CPU-AUTO or failed to start or stop) then the number of the input or output point is put into variable #25.

The alarm codes, which are put into variable #24 are:

Alarm Code	Meaning
0	no error
1	digital output error
2	analog output error
3	digital input error
4	analog input error

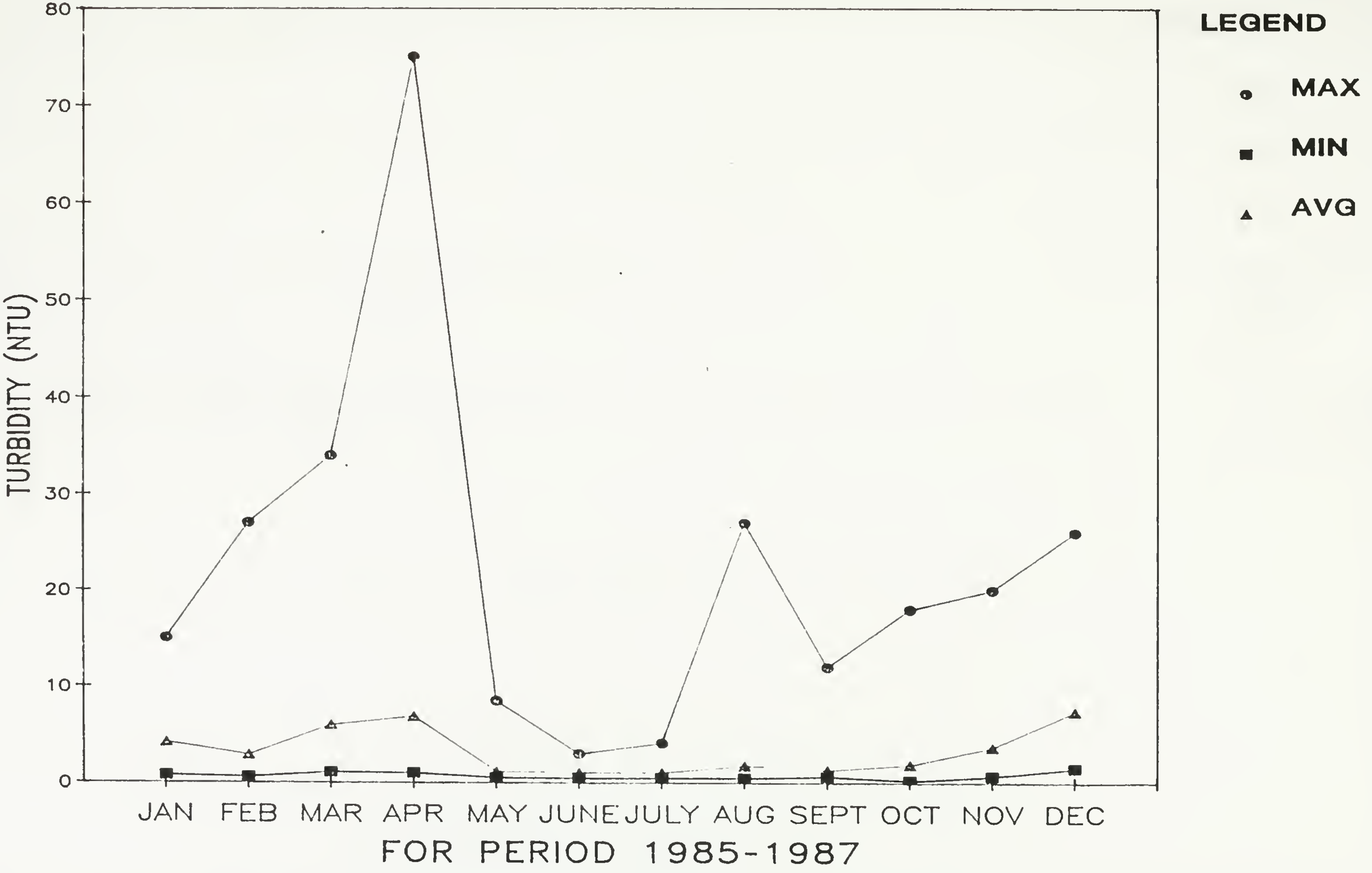
APPENDIX C

GRAPHICAL TURBIDITY DATA

OSHAWA WTP

FIGURE 1.0: COMPOSITE PROFILE

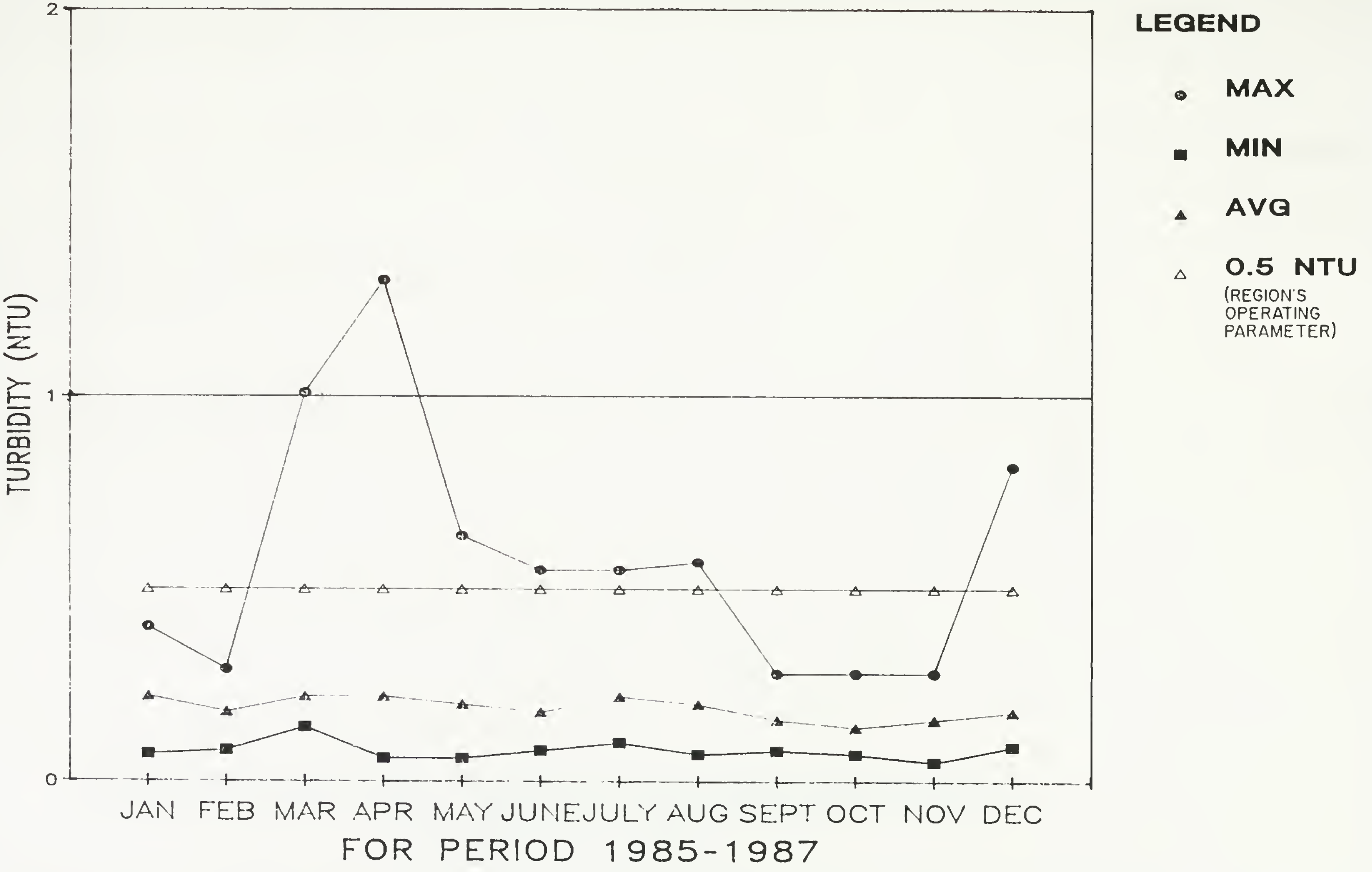
RAW WATER TURBIDITY RANGES



OSHAWA WTP

FIGURE 1.1: COMPOSITE PROFILE

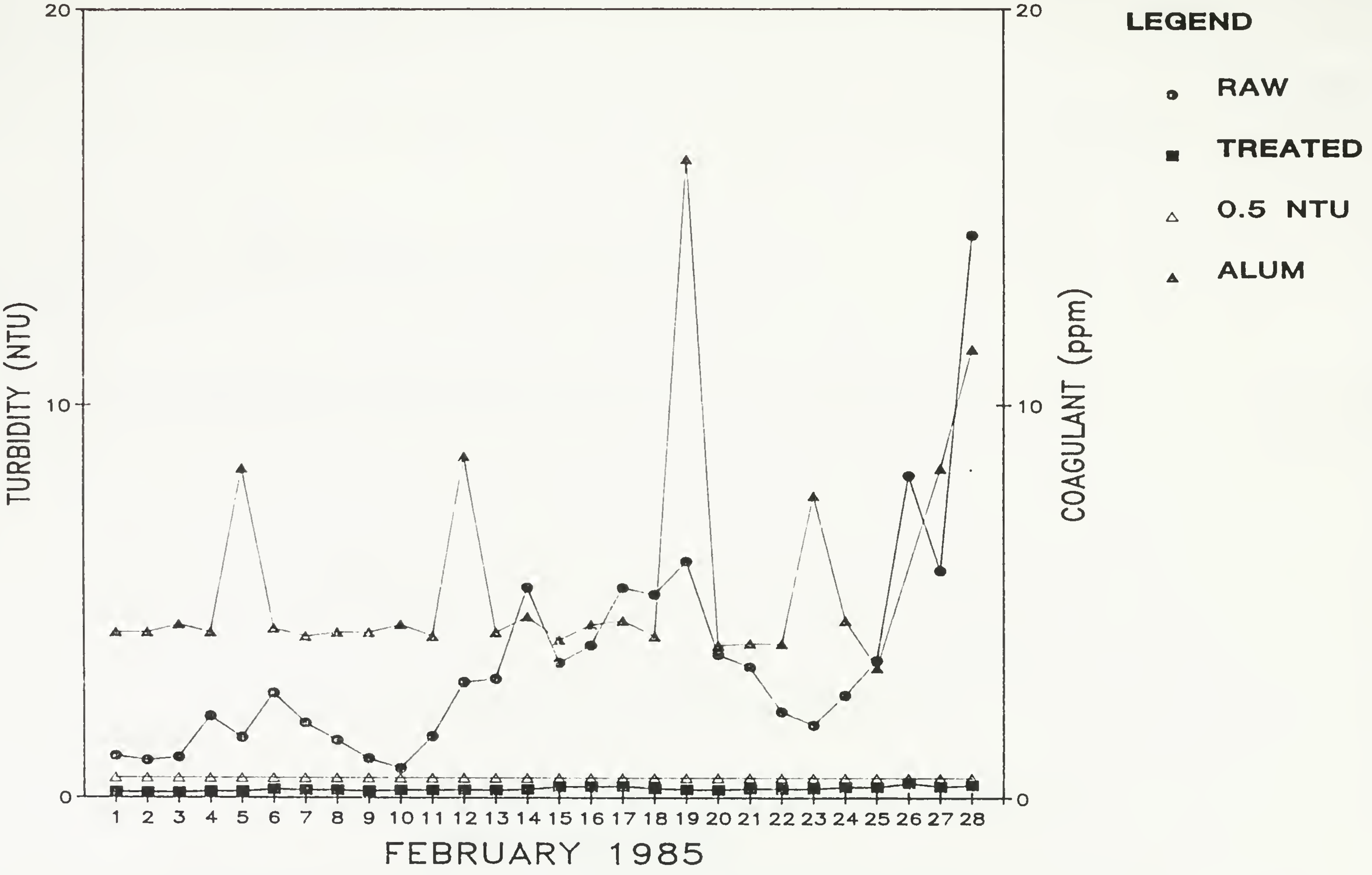
TREATED WATER TURBIDITY RANGES



OSHAWA WTP

FIGURE 2.0a: PERFORMANCE PROFILE

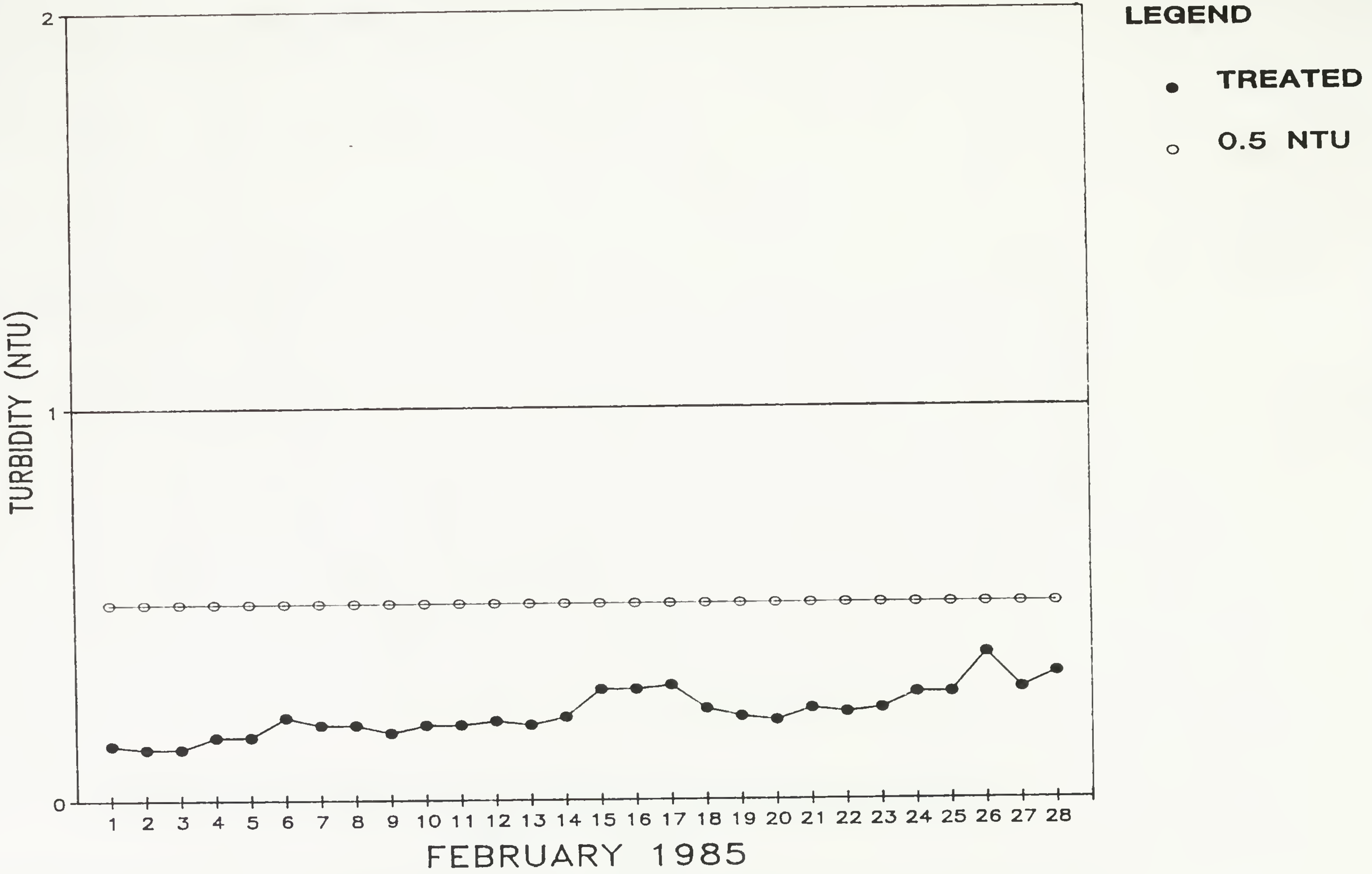
DAILY TURBIDITY READINGS



OSHAWA WTP

FIGURE 2.0b: PERFORMANCE PROFILE

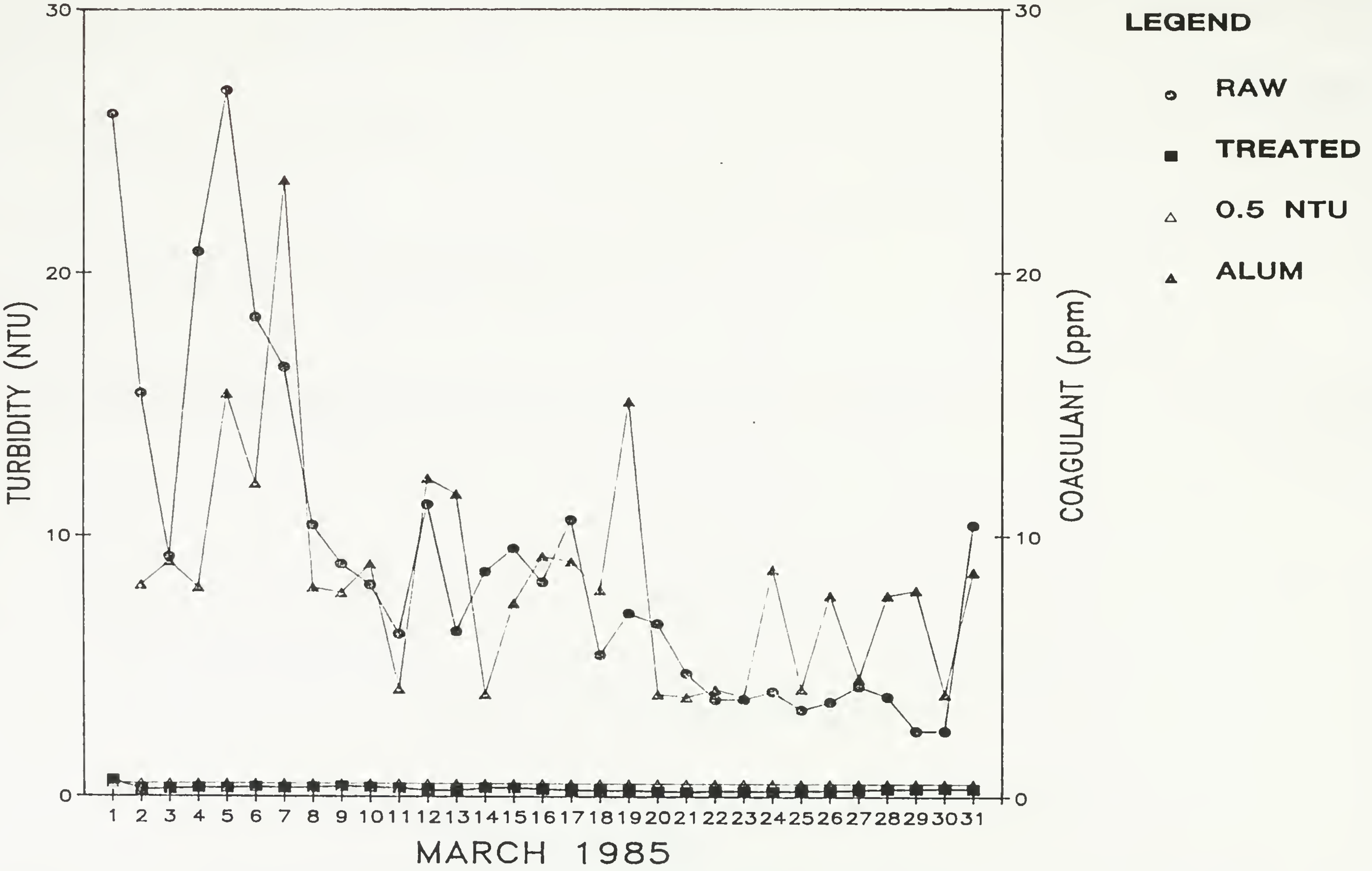
DAILY TURBIDITY READINGS



OSHAWA WTP

FIGURE 3.0a: PERFORMANCE PROFILE

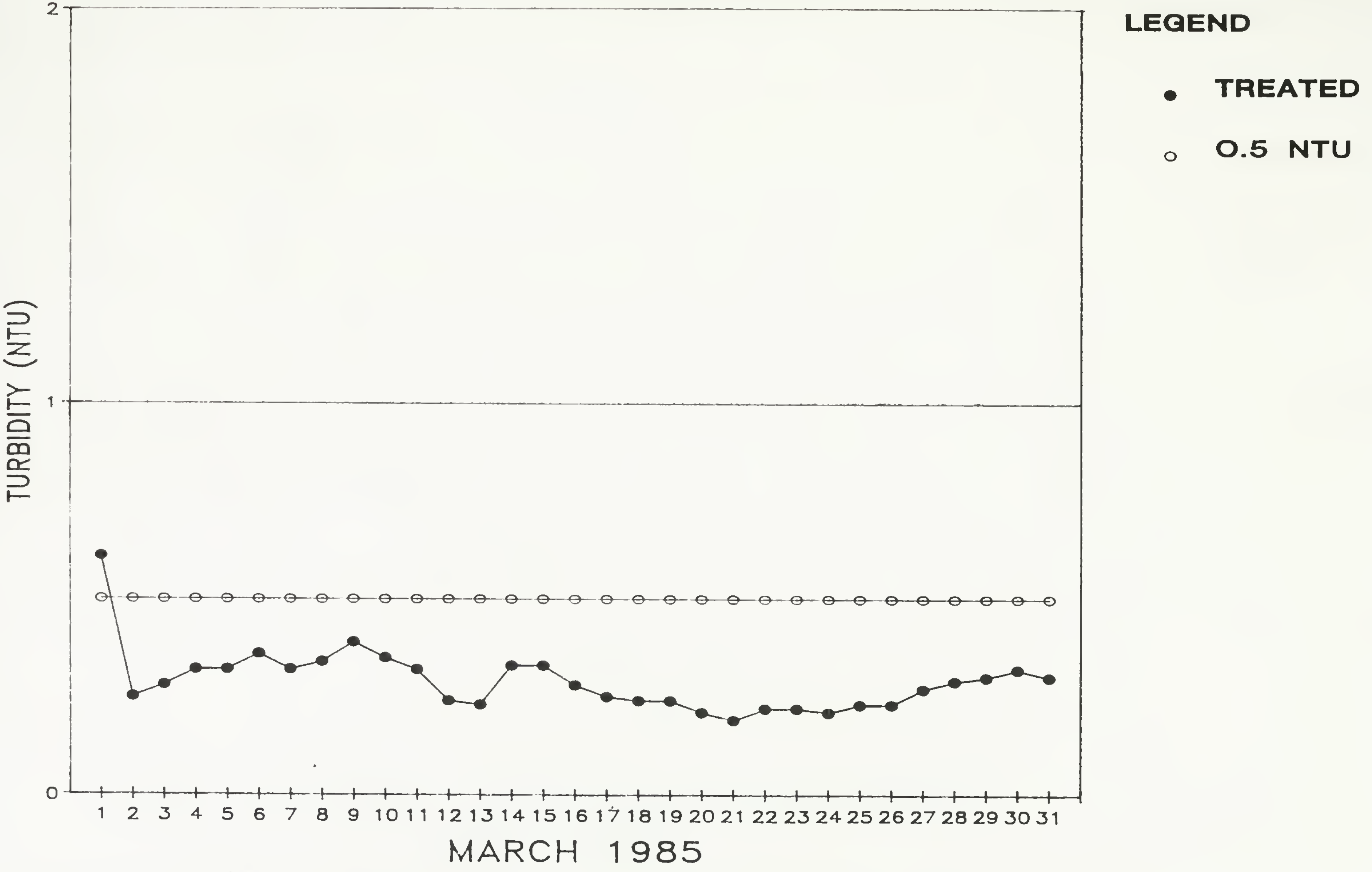
DAILY TURBIDITY READINGS



OSHAWA WTP

FIGURE 3.0b: PERFORMANCE PROFILE

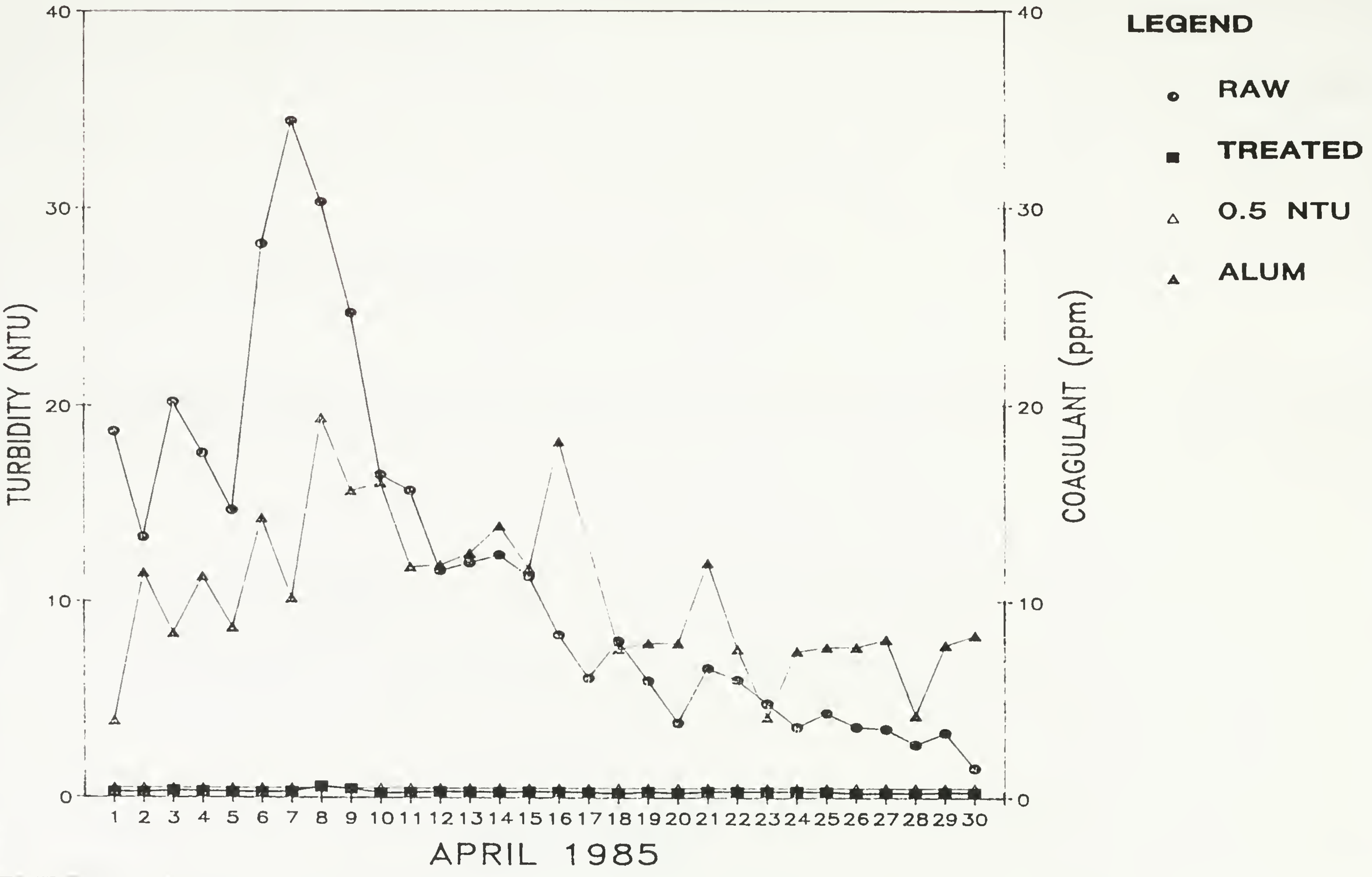
DAILY TURBIDITY READINGS



OSHAWA WTP

FIGURE 4.0a: PERFORMANCE PROFILE

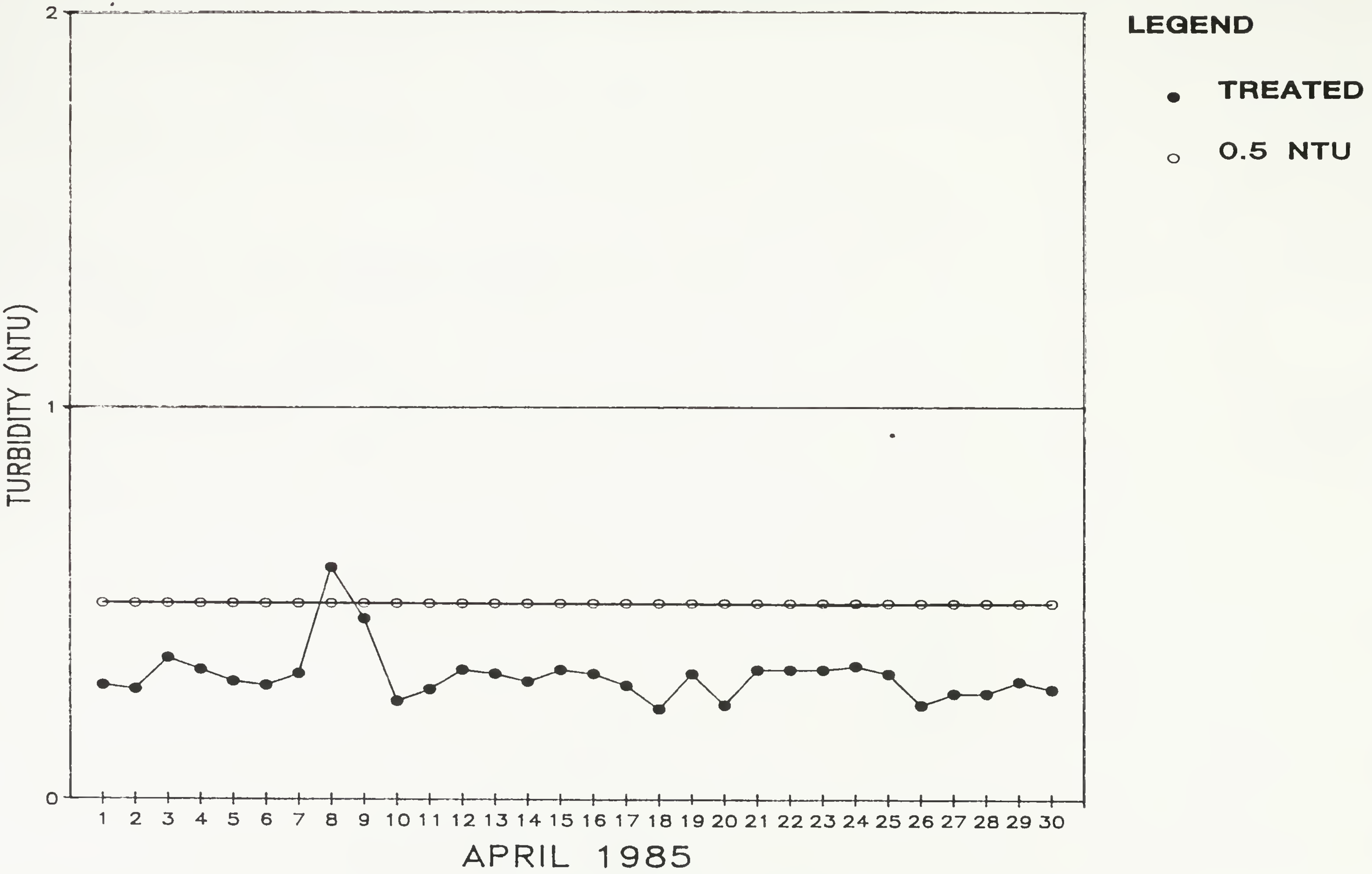
DAILY TURBIDITY READINGS



OSHAWA WTP

FIGURE 4.0b: PERFORMANCE PROFILE

DAILY TURBIDITY READINGS



APPENDIX D

JAR TESTING

Gore & Storrie Limited

SHEET NO. 1

LABORATORY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
27 Oct. 87	MOE Water Plant Optimization Study Oshawa Water Treatment Plant	380.81

SAMPLE NO. & DESCRIPTION

(1) Raw water sample No. 1 collected 22 October 1987.

(2) Raw water sample No. 2 collected 24 November 1987.

(3)

(4)

(5)

PARAMETERS	SAMPLE (1)	SAMPLE (2)	SAMPLE (3)	SAMPLE (4)	SAMPLE (5)
pH	7.90	8.21			
Colour (HCU)	<5	<5			
Turbidity (NTU)	0.60	3.1			
Alkalinity (mg/L as $CaCO_3$)	86	94			
Hardness (mg/L as $CaCO_3$)	135	137			
Aluminum (mg/L as $CaCO_3$)	0.04	0.10			
Iron (mg/L)	0.01	0.06			
Manganese (mg/L)	<0.05	<0.05			

CONDUCTED BY	REVIEWED BY

Gore & Storrie Limited TEST NO. 1

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
28 Oct.87	MOE - Water Plant Optimization Study Oshawa Water Treatment Plant	380.81

TEST DESCRIPTION

Removal of Turbidity with Alum - 1 Litre Jar Tests
Raw Water Sample No. 1

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	(2) Alum			pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	Al (mg/L)
1									
2	3		4-5	7.90	0.14	<5	84	133	0.34
3	5		4	7.87	0.13	<5	83	134	0.43
4	7		3	7.84	0.14	<5	82.5	135	0.40
5	10		2	7.81	0.13	<5	82	135	0.35
6	15		1-2	7.78	0.12	<5	79	135	0.30
7	20		1-2	7.67	0.13	<5	77	135	0.21
RAW, UNTREATED				7.90	0.60	5	86	135	0.04

SAMPLE TEMPERATURE Start: 25°C Finish: 25°C

COMMENTS

(1) Treatment Steps: Alum added, stirred at greater than 100 rpm for 2 minutes, 30 rpm for 30 minutes; settled for 30 minutes and filtered through a 1.2 µm membrane filter by vacuum filtration.

(2) Commercial grade equivalent $Al_2(SO_4)_3 \cdot 14H_2O$ added from a 10 mg/mL solution.

Floc Rating:
1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

Gore & Storrie Limited

TEST NO. 2

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
25 Nov./87	MOE Water Plant Optimization Study - Oshawa Water Treatment Plant	380.81

TEST DESCRIPTION

Removal of Turbidity with Alum and Polymer -
1 Litre Jar Tests, Raw Water Sample #2

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	WATER QUALITY AFTER TREATMENT					
	(2) Alum	Poly(3) 834A		pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Al. (mg/L)	
raw									
2	5	0	3-4	8.16	0.26	<5	90	0.38	
3	5	0.1	3	8.18	0.21	<5	91	0.37	
4	5	0.3	3	8.17	0.18	<5	91	0.32	
5	5	0.5	3	8.16	0.24	<5	92	0.37	
6	30	0	1-2	7.90	0.21	<5	83	0.13	
7	50	0	2	7.71	0.26	<5	81	0.08	
RAW,UNTREATED				8.21	3.1	<5	94	0.10	

SAMPLE TEMPERATURE Start: 24°C Finish: 24°C

COMMENTS

(1) Treatment Steps: Alum and Polymer added; stirred at greater than 100 rpm for 2 minutes, 30 rpm for 30 minutes; settled for 30 minutes and filtered through a 1.2 μm membrane filter by vacuum filtration.

(2) Commercial grade equivalent $Al_2 (SO_4)_3 \cdot 14H_2 0$ added from a 10 mg/mL solution.

(3) American Cyananid Magnifloc 834A (anionic) added from a 0.1 mg/mL solution.

Floc Rating:		
	1 - very good	4 - very poor
	2 - good	5 - no floc
	3 - poor	

CONDUCTED BY

REVIEWED BY

Gore & Storrie Limited

TEST NO. 3

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
25 Nov/87	MOE Water Plant Optimization Study - Oshawa Water Treatment Plant	380.81

TEST DESCRIPTION

Removal of Turbidity with Alum and Polymer - 1 Litre Jar Tests
Raw Water Sample #2

JAR NO.	CHEMICAL DOSAGES (mg/L)			FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	(2) Alum	(3) Poly 900N	(4) Poly 587C		pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Al. (mg/L)	
raw										
2	5	0.1		2-3	8.16	0.21	<5	92	0.29	
3	5	0.3		2-3	8.17	0.21	<5	92	0.35	
4	5	0.5		2	8.17	0.21	<5	92	0.36	
5	5		0.1	2	8.12	0.25	<5	94	0.36	
6	5		0.3	1-2	8.14	0.21	<5	92	0.36	
7	5		0.5	2	8.14	0.21	<5	92	0.33	
RAW, UNTREATED					8.21	3.1	<5	94	0.10	

SAMPLE TEMPERATURE Start: 24.0°C Finish: 24.0°C

COMMENTS

(1) Treatment Steps: Alum and Polymer added; stirred at greater than 100 rpm for 2 minutes, 30 rpm for 30 minutes; settled for 30 minutes and filtered through a 1.2 μm membrane filter by vacuum filtration.

(2) Commercial grade equivalent $Al_2(SO_4)_3 \cdot 14H_2O$ added from a 10 mg/mL solution.

(3) American Cyanamid Magnifloc 900N (non ionic) added from a 0.1 mg/mL solution.

(4) American Cyanamid Magnifloc 587C (cationic) added from a 0.1 mg/mL solution.

Floc Rating:

1 - very good
2 - good
3 - poor
4 - very poor
5 - no floc

CONDUCTED BY	REVIEWED BY

Gore & Storrie Limited TEST NO. 4

WATER TREATABILITY RESULTS SHEET

DATE	PROJECT DESCRIPTION	JOB NO.
9 Dec.87	MOE - Water Plant Optimization Study Oshawa Water Treatment Plant	380.81

TEST DESCRIPTION

Removal of Turbidity with Alum - 1 Litre Jar Tests
Raw Water Sample No. 2

JAR NO.	CHEMICAL DOSAGES (mg/L)		FLOC RATING	(1) WATER QUALITY AFTER TREATMENT					
	(2) Alum			pH	Turb. (NTU)	Colour (HCU)	Alk. (mg/L)	Hard. (mg/L)	
1									
2	3		4	7.96	0.15	<5	94	137	
3	5		3	7.95	0.14	<5	92	137	
4	7		2-3	7.92	0.15	<5	91	137	
5	10		2	7.91	0.17	<5	89	137	
6	15		1-2	7.83	0.18	<5	88	137	
7	20		1-2	7.73	0.15	<5	85	137	
RAW, UNTREATED				8.01	2.5	<5	94	137	

SAMPLE TEMPERATURE Start: 24.0°C Finish: 24.0°C

COMMENTS

(1) Treatment Steps: Alum added, stirred at greater than 100 rpm for 2 minutes, 30 rpm for 30 minutes; settled for 30 minutes and filtered through a 1.2 µm membrane filter by vacuum filtration.

(2) Commercial grade equivalent $Al_2(SO_4)_3 \cdot 14H_2O$ added from a 10 mg/mL solution.

Floc Rating:	
	1 - very good
	2 - good
	3 - poor
	4 - very poor
	5 - no floc

CONDUCTED BY

REVIEWED BY

APPENDIX E

DAILY RECORD

THE REGIONAL MUNICIPALITY OF DURHAM
OSHAWA WATER SUPPLY PLANT.
FILTRATION AND PUMPING DAILY LOG

Date 19

ND 1 AND NO 2 — FILTRATION PLANT OPERATION

FILTER	M N	1	2	3	4	5	6	7	8	9	10	11	Noon	13	14	15	16	17	18	19	20	21	22	23	Hrs Run	Rate	Water Used	Est. Total	Backwashing Remarks
1																													
2																													
3																													
4																													
5																													
6																													
7																													
8																													
1																													
2																													
3																													
4																													
5																													
6																													
Total																													

HORTOP B S										WAVERLY B.S.								GRANDVIEW B S			
1M		2M		4D		3MR		5DR		1M		2M		3M		1D		1M		2M	
IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT

HARMONY B S			
1		2	
IN	OUT	IN	OUT

LOW LIFT PUMPING PLANT OPERATION

Pump																									Low Head Hrs Run	Pumpage	B/W Pump & Diesel Gen Hrs. Run
1M																											
2M																											
3M																											
4M																											
OLH																											
OLH																											
Turbine																											
No 1 B/W																											
No 2 B/W																											
Diesel Gen																											
Total																											

METER READINGS

	No 1 Meter	No 2 Meter	Total Meter	No 1 B/W Meter	Low Lift Meter	Cl Cyl Scales	Fluoride	Alum Sulphate	No 2 B/W Meter	K W H. Meter	Fluoride Scale	Alum Scale	Fluoride Test	Turbidity P P M	
Midnight															
Previous Midnight															
Difference															

TEMPERATURES AND WEATHER RECORDS

	R/W Temp	Atmos Temp	Wind Direction	Barometer	Lake Condition	Weather	Remarks	OPERATOR
1st Shift								
2nd Shift								
3rd Shift								

HIGH LIFT PUMPING PLANT OPERATION

Pump	M N	1	2	3	4	5	6	7	8	9	10	11	12 Noon	13	14	15	16	17	18	19	20	21	22	23	High Head Hrs Run	Pumpage
3M																										
4M																										
5M																										
6M																										
7M																										
8M																										
OHH																										
OHH																										
OHH																										
OHH																										
OHH																										
Total																										

REMARKS REPAIRS EFFECTED, ETC

	PRE CHLORINATION					FINAL CHLORINATION				TURBIDITY				PH COMPARATOR TEST				COAGULATION			
											Turbidity J T.U				Test Results						
Shift	Time	Test P P M	Feed Rate	Adjusted Rate	Clear Well	Time	Test P P M	Feed Rate	Adjusted Rate	Time	Raw Water	Filt Water	Filt Influ	Time	Raw Water	Filt Influ	City Supply	Time Start	Time Stop		Rate G P G
FIRST																					
SECOND																					
THIRD																					

	SOLUTION FEEDER				FIRE CALLS				Screen Well	No 1 Clear Well	No 2 Clear Well	FLOW					SUPPLIES USED
Shift	Time Start	Time Stop	Chem Used	Feed Rate	Time Rec'd	Time All Clear	Time Duration	Pressure	Elevation	Elevation	Elevation	Time	No 1 Meter	No 2 Meter	Total Meter	Pressure	
FIRST												Mid-Night					
												A M 2 00					
SECOND												A M 10.00					
												P M 2 00					
THIRD												P M 6 00					
												P M 9 00					

BACTERIOLOGICAL TEST PROCEDURES
OSHAWA WATER TREATMENT PLANT

Bacteriological Testing

The plant operating staff (maintenance operators) at the Oshawa Water Treatment Plant collect bacteriological samples at the Oshawa, Whitby and Ajax plants and in the distribution system.

As of 1988, Oshawa raw water samples are collected once a week for bacteriological analysis, and the plant effluent is sampled twice a week. These samples are forwarded to the Ministry of the Environment laboratory in Rexdale for analysis. The lab results are sent to the Oshawa plant and reviewed by plant staff.

Procedure Following Positive Bacteriological Results

In general, the following procedure is used if positive bacteriological test results occur. Each situation is examined individually, and more action may be taken, depending on the situation.

If a positive sample occurs, the plant staff notify the Technical Support Section of the Regional Municipality of Durham Works Department. The support group re-samples the location and investigates the occurrence (ie. checks chlorine residuals etc.). Depending on the investigation, the support group will advise the Oshawa plant on any required treatment modifications.

APPENDIX G

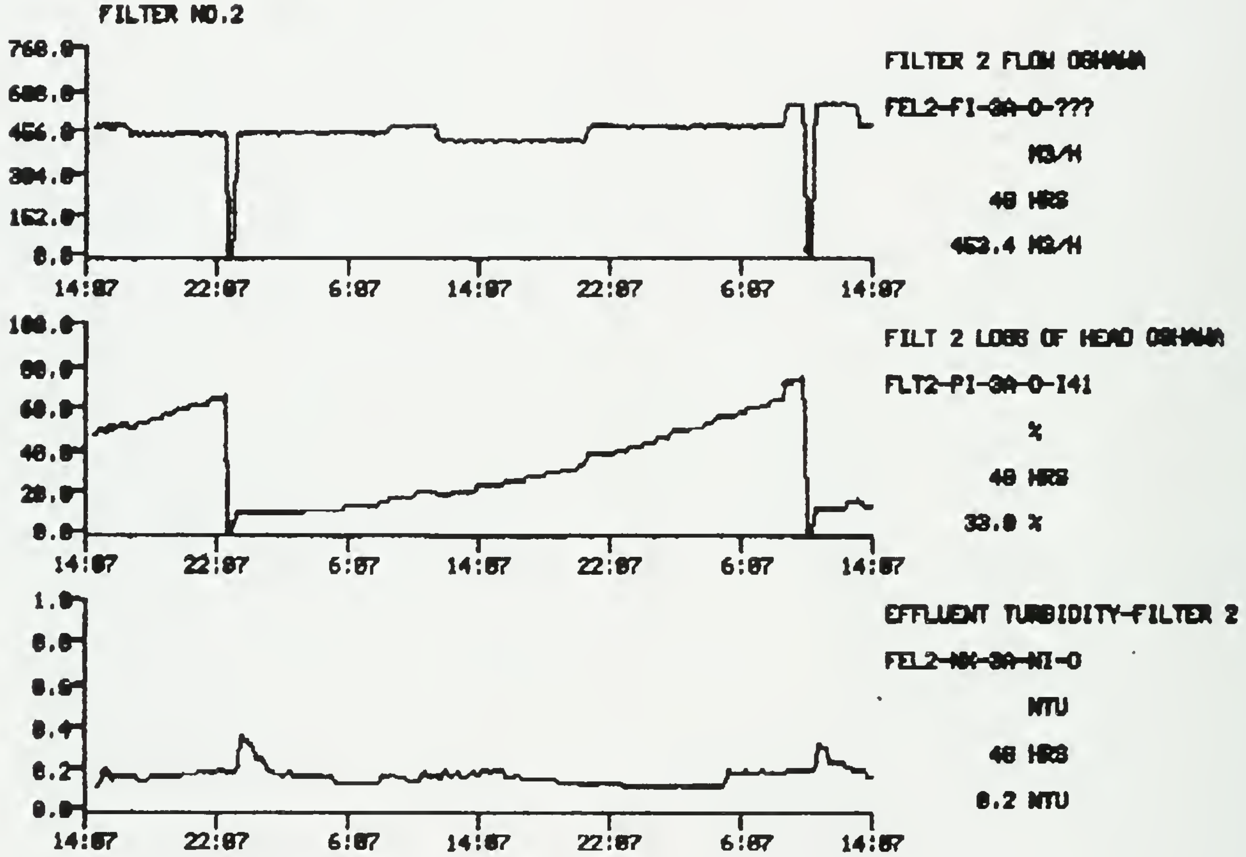
COMPUTER PRINTOUTS - OPERATIONAL SUMMARIES

COMPUTER PRINTOUTS - OPERATIONAL SUMMARIES

The following pages contain examples of the operational summaries and graphics which can be generated by the computerized supervisory control, data acquisition and maintenance control system. The computer contains a large database of plant operating which can be accessed at any time.

1987 12 17 14:17
PAGE 2 OF 6

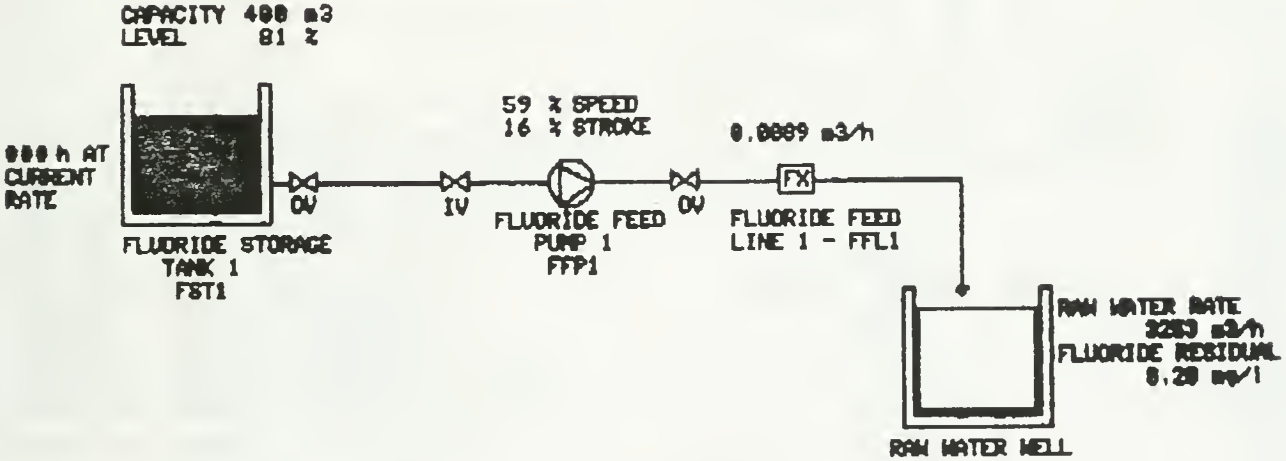
OSHAWA FILTER TRENDS



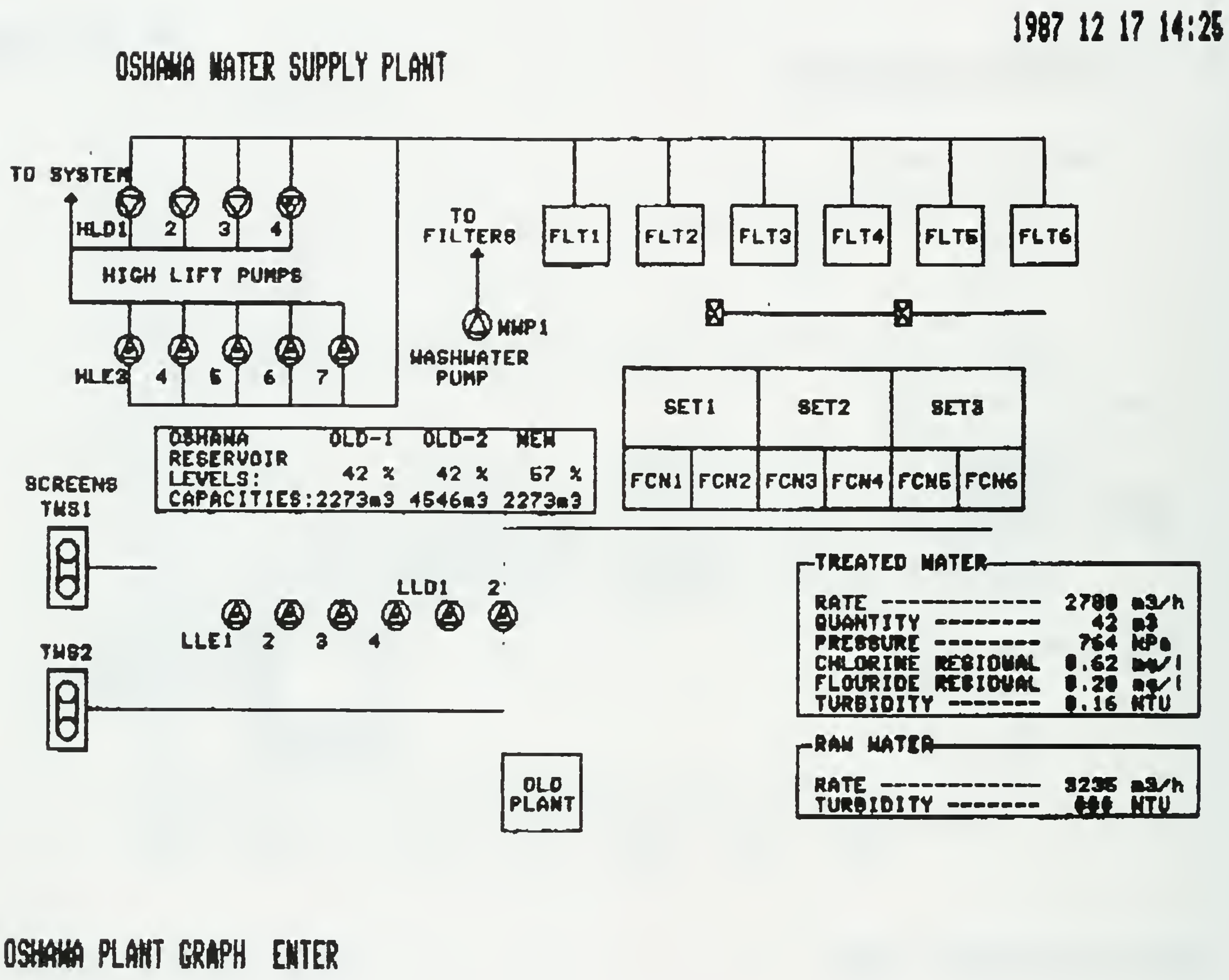
OSHAWA FILTER TREND ENTER

1987 12 17 14:24

OSHAWA FLUORIDE SYSTEM



OSHAWA FLUORIDE GRAPH ENTER



```
1987 12 17 14:25

OSHAWA WATER SUPPLY PLANT

OSHAWA          OLD-1   OLD-2   NEW
RESERVOIR
LEVELS:          42 %    42 %    67 %
CAPACITIES:2273m3 4546m3 2273m3

TREATED WATER

RATE -------------      2780 m3/h
QUANTITY ---------        42 m3
PRESSURE ---------       764 kPa
CHLORINE RESIDUAL       0.62 mg/l
FLOURIDE RESIDUAL       0.20 mg/l
TURBIDITY --------      0.16 NTU

RAW WATER

RATE -------------      3235 m3/h
TURBIDITY --------  [illegible] NTU

OSHAWA PLANT GRAPH  ENTER
```

```
                                                                         1987 12 17 14:26
      OSHAWA PLANT STATUS                                                 PAGE 1 OF 2

POINT ID  DESCRIPTION                     CAPACITY    STATUS          RUN TIME   CONTROL
FLT1      FILTER 1                         760 m3/h   ON   - OK -      -         CPU-NOR
FLT2      FILTER 2                         760 m3/h   ON   - OK -      -         CPU-NOR
FLT3      FILTER 3                         760 m3/h   ON   - OK -      -         CPU-NOR
FLT4      FILTER 4                         760 m3/h   ON   - OK -      -         CPU-NOR
FLT5      FILTER 5                         760 m3/h   ON   - OK -      -         CPU-NOR
FLT6      FILTER 6                         760 m3/h   ON   - OK -                CPU-NOR
RWL1-FI   RAW WATER FLOW                              3235 m3/h          -       CPU-NOR
SWC1-LI   SETTLED WATER LEVEL                           1 %              -       CPU-NOR
SWC1-NX   SETTLED WATER TURBIDITY                     ### NTU            -       CPU-NOR
RWL1-CV   FLOW CONTROL VALVE 1                        100 %              -       LOCAL
RWL2-CV   FLOW CONTROL VALVE 2                        100 %              -       LOCAL
TWL1-FI   TREATED WATER FLOW DIESEL                    31 m3/h           -       CPU-NOR
TWL2-FI   TREATED WATER FLOW ELECTRIC                2749 m3/h           -       CPU-NOR
TWL1-PI   TREATED WATER PRESSURE                      764 kPa            -       CPU-NOR
GARL-LI   RESERVOIR LEVEL                13636 m3      70 %              -       CPU-NOR



OSHAWA PLANT STAT  ENTER
```

TERMS OF REFERENCE

Purpose

To review the present conditions and determine an optimum treatment strategy for contaminant removal at the plant, with emphasis on particulate materials and disinfection processes.

Work Tasks

1. Receive an information package from the MOE. Review the information provided and meet with the MOE staff, if required, to discuss the project.

2. Document the quality and quantity of raw and treated waters.

3. Define the present treatment processes and operating procedures. Prepare a progress report on Works Tasks 1-3 for the Project Committee.

4. Assess the methods of efficient particulate removal which would utilize the present major capital works of the plant. Evaluate the particulate removal efficiency and sensitivity of operation, assuming optimum performance of the plant.

5. Assess current disinfection practices and possible improvement methods.

6. Describe possible short and long-term process modifications to obtain optimum disinfection and contaminant removal.

7. Prepare a draft report for the project committee's review.

8. Prepare the final report.

1. RECEIVE AN INFORMATION PACKAGE FROM THE MOE. REVIEW THE INFORMATION PROVIDED AND MEET WITH THE MOE STAFF, IF REQUIRED, TO DISCUSS THE PROJECT.

Elements of Work

(a) Receive an information package from the MOE concerning the plant and the study. This package includes a general terms of reference, a general table of contents for organizing the study in a manner consistent with other plant reports, the WPOS reporting tables and a copy of Ontario Drinking Water Objectives.

(b) Review the information and prepare for a meeting to initiate the work on the project, including preparation of a schedule of manpower and staff committments.

(c) Meet with the MOE to discuss the available data, the terms of reference, and the project staff and work schedule. If a consultant is carrying out more that one study it may not be necessary to meet with the MOE at the start of each study.

2. DOCUMENT THE QUALITY AND QUANTITY OF RAW AND TREATED WATERS.

Elements of Work

(a) Prepare a monthly summary of maximum, minimum, and average flows for the last three consecutive years (Table 1.0). Address any discrepancies which exist between raw and treated flow rates.

(b) Based on the above, briefly review and tabulate for the last three years, the monthly maximum, minimum, and average per capita flow for the total population served by the plant (Table 1.1). Compare the plant data with typical per capita flows for the local region. Indicate major consumers who may influence the figures.

(c) Document the methods of measuring the raw and treated water flow rates.

(d) Summarize, for the last three consecutive years, where available, the raw and treated water; turbidity, colour, residual aluminum/iron, pH, temperature and treatment chemical dosages (other than disinfection and fluoridation). The summary should indicate the monthly daily average and maximum and minimum day (Table 2.0).

For the same three year period, tabulate also the daily average for the typical seasonal months of January, April, July and October as well as other months in which problems with particulate removal occurred (Tables 2). Document enough data to define and evaluate those problems.

Record other data, such as particulate counting, suspended solids, and algae counting (Table 5.0) which could reflect on particulate removal efficiency.

Document the source and methods used in determining all information.

A comparison should be made between the plant and outside laboratory information to ascertain the relative validity of the data. For plant data, emphasis should be given to plant laboratory tests rather than continuous process control instruments.

(e) Summarize for the last three consecutive years, where available, the disinfectant demand, dosages (including all disinfection related chemicals and residuals) for all application points as well as fluoridation dosage and residual. The summary should indicate the monthly daily average and maximum and minimum day (Table 3.0).

For the same three year period, tabulate (Table 3) the daily average for the typical seasonal months of January, April, July and October as well as other months in which problems with chlorine residuals and/or positive bacterial tests identified in Table 6. Document enough data to define and evaluate those problems.

Document the methods of dosage evaluation and residual measurements, and establish the validity of the data provided.

(f) Prepare a summary, based on at least three years of data, of the raw and treated water quality testing data for physical, microbiological, radiological, and chemical water quality information (Table 4). Document as much data as is needed to show possible seasonal trends in water quality. Where possible, show corresponding sets of raw and treated water quality information.

Document the source and methods used in determining all water quality information and establish the validity of the data, comparing plant and outside laboratory data.

(g) Tabulate, for the last three consecutive years, the raw and treated water bacterial test information at the plant (Table 6).

Document the source and methods used for all data provided.

(h) Document the water sampling systems (source, pump, line-material and size, vertical rise velocity sampling location) used in the plant (similar to DWSP Questionnaire in Appendix A).

(i) Prepare a summary of inplant testing including Test, Sampling Point, Testing Frequency, Reporting Frequency, Testing Instrumentation including calibration.

(j) Identify other water quality concerns, not related to particulate removal or disinfection, which should be considered as part of the assessment phase of this evaluation program.

3. DEFINE THE PRESENT TREATMENT PROCESSES AND OPERATING PROCEDURES. PREPARE A PROGRESS REPORT ON WORK TASKS 1-3 (8 COPIES), FOR THE PROJECT COMMITTEE.

Elements of Work

(a) Where drawings are available, assemble sufficient record drawings of a reduced size, to document the general site layout and the interrelationship of major plant components. If available, include a process and piping diagram (PAPD) of the plant operations.

(b) Prepare a simplified block schematic of all major plant components including chemical systems and indicating design parameters. Appendix B is an example of the required standard schematic.

(c) Prepare a photographic record of the plant facilities, illustrating all of the major plant components and chemical feed systems. The record should include approximately 30-40 coloured (9 cm x 12 cm) (or 10 cm x 15 cm) prints, suitably labelled. The progress and draft reports may include photocopies in lieu of the prints.

(d) Tabulate the design parameters for all the major plant components, with emphasis on the process operations, including chemical feeds. This information, as a minimum, must be consistent with the DWSP Questionnaire (Appendix A) and must be confirmed and verified by field observations. The design parameters should be evaluated at design, rated and actual operational flows.

(e) Prepare a summary of how the plant is operated, including chemical dosage control, such as jar testing information, filter backwashing procedures and initiation, and pumping and flow control.

(f) Document all reported and other apparent problems in plant operations and/or in the distribution system related to water quality. In addition list the health related parameters which exceed the Ontario Drinking Water Objectives (Table 7).

(g) Submit 8 copies of the progress report to the Prime Consultant for distribution to the Project Committee.

4. ASSESS THE METHODS OF EFFICIENT PARTICULATE REMOVAL WHICH WOULD UTILIZE THE PRESENT MAJOR CAPITAL WORKS OF THE PLANT. EVALUATE THE PARTICULATE REMOVAL EFFICIENCY AND SENSITIVITY OF OPERATION, ASSUMING OPTIMUM PERFORMANCE OF THE PLANT.

Elements of Work

(a) Assess the validity and implication of all information relating to particulate removal provided in Work Tasks 1 and 2 with emphasis on method, metering and sampling, etc.

(b) Using information provided in Work Tasks 1, 2 and 3 evaluate the plant's particulate removal efficiency. The basis of minimum particulate removal should be 1.0 F.t.u. It should, however, be recognized that it is desirable to strive for an operational level which is as low as is achievable.

(c) Conduct an evaluation of possible optimum performance alternatives. Include jar testing using established industry practice.

(d) Evaluate the feasibility of optimum removal using the existing plant capital works. This evaluation should consider the worst case water quality conditions, even though field testing data may not be available during the initial phase of the study (see Work Task 7).

(e) Describe the operational procedures, management strategies, and equipment required for various feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation of the alternatives.

5. ASSESS CURRENT DISINFECTION PRACTICES AND POSSIBLE IMPROVEMENT METHODS.

Elements of Work

(a) Assess the validity and implication of all information relating to disinfection provided in Work Tasks 1, 2 and 3 with emphasis on method, metering and sampling etc.

(b) Using the information provided in Work Tasks 1, 2 and 3 evaluate the plant's ability to disinfect the water. The basis of minimum disinfection should be to ensure a water quality as described in the Ontario Drinking Water Objectives.

(c) Conduct an evaluation of possible optimum disinfection procedures for the plant, with consideration also given to the reduction of chlorinated by-products in the treated water.

(d) Evaluate the feasibility of the various alternatives using the existing plant capital works.

(e) Assess the relative merits of the alternatives. Describe the operational procedures, management strategies, and equipment required for the feasible alternatives. Estimate chemical dosages, level of operational expertise, and sensitivity of operation for the alternatives.

6. DESCRIBE POSSI[illegible] HORT AND LONG-TERM PROCESS MODIFICATIONS TO OBTAIN OPTIMUM [illegible]FECTION AND CONTAMINANT REMOVAL.

Elements of Work

(a) Prepare a list of modifications which should be considered for detailed implementation evaluation. Provide an estimated cost and possible schedule for implementation for each of the proposed modifications.

It is not the purpose of this study to provide a detailed implementation scheme for plant rehabilitation. It is, however, necessary to scope the feasible short and long-term process modifications required to achieve optimum disinfection and contaminant removals.

(b) Incorporate (a) above in the draft report.

7. PREPARE A DRAFT REPORT FOR THE PROJECT COMMITTEE'S REVIEW. (8 COPIES).

Elements of Work

(a) The report must include all information for Work Tasks 1-6.

The information must be organized and presented in a logical and co-ordinated fashion. A general table of contents (Appendix C) is provided for organizing the material in a manner consistent with other plant reports.

Submit the draft report for review by the Project Committee.

(b) Meet with the Project Committee on site at least one week after submission of the report.

(c) Prepare a separate letter report containing recommendation(s) concerning the need for additional field testing to cover quality conditions not available during the period of this study. The Project Committee may decide to delay completion of the final report until field data can be obtained to confirm the predictions of performance for the worst case water conditions.

8. PREPARE THE FINAL REPORT.

Elements of Work

(a) Conduct additional field testing if required. Discuss the implementations of the results with the Project Committee if the results differ from the predicted performance.

(b) Amend the report as per review comments, incorporating additional field data if required.

(c) Submit 25 copies of the final reports (including the colour photographs) to the MOE for distribution.